MINIATURE BOAT BUILDING

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MINIATURE BOAT BUILDING

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The Construction of Working Models of Racing, Sail and Power Boats

A CONCISE AND COMPLETE PRACTICAL TREATISE FOR THE AMATEUR AND PROFESSIONAL MECHANIC GIVING SPECIFIC INSTRUCTIONS IN SIMPLE LANGUAGE ON THE VARIOUS PROCESSES AND OPERATIONS INVOLVED IN BUILDING

MODEL RACING, SAIL AND POWER BOATS AND POWER PLANTS

BY

ALBERT C. LEITCH

Naval Architect, Author of "Motor Boats and Boat Motors"

PEABODY MUSEUM OF SALEM

Illustrated by a series of five hundred progressive illustrations showing clearly every step of the construction of the boats described

NEW YORK

THE NORMAN W. HENLEY PUBLISHING CO.

2 WEST 45TH STREET

1928

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Printed in United States of America

PREFACE

In the preparation of this book, I have attempted, by every means possible to make it the most authentic work of its kind ever offered to the public. In brief, it is a treatise on the construction of properly designed working models of racing boats, adapted as far as practicable from the actual, full size boats.

The little craft, the designs of which will be found within these covers, are based upon the same principles that govern the design of full sized power and sailing yachts, yet I have tried my best to so word each chapter that it will be understandable to the novice and at the same time, acceptable to the more skilled.

I have, wherever possible, reduced the difficult nautical terms to the simplest lay language which, I hope, will make it interesting to "son," "dad" and the "young-old-man."

The boats, when completed, will look and act like real ones because they are practically and scientifically correct for the particular work they are to do. Without realizing it, the builder of one of these models will be forming for himself, at the same time, a firm foundation in the governing principles of naval architecture.

And now, before we take up the burden of the book, I want to take this brief opportunity to thank those who have so cheerfully aided me in compiling the contents

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which follow. To these men, who have spent most of their lives in yacht design, marine engineering and model making, I dedicate this work, in the hope that it may, at least in part, repay them for their assistance.

Albert C. Leitch,

Naval Architect.

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INTRODUCTION

It is the object of this book to explain concisely the construction and operation of sail and power driven racing yachts and through a careful reading of these pages it will be possible for the beginner to build the boat of his choice, which, when completed, will have the value and appearance of a professional job. The construction methods have been developed by experts who have made model making their life work, and the same painstaking mathematical calculations have been made in the designs of these little boats as is customary with large ones.

The design of a successful racing yacht, sail or power, involves the two highest and most technical sciences known; naval architecture and marine engineering. Calculations are made before the boats are built which determine most accurately every characteristic. It is ascertained, in advance, just how they will behave under different loading or wind conditions; how much power they will require to drive them at a given speed; just how far over a racing sail model will lean with a wind of a certain volocity, etc. You have often seen a toy sail boat capsize with a slight puff of wind, but such a calamity is scarcely ever heard of in the case of a properly designed sail boat because the designer has determined, by calculation in advance, the proper ratio between the sail area, boat displacement and keel weight.

Each type of boat in this book has been built and

tested and has passed rigid and critical inspections by keen-minded authorities. The reader is given a concise but complete treatise on amateur marine model making in general, and the specific construction of numerous miniature racing sailing yachts, and also steam, electric and spring motor driven power boats. Complete drawings and specifications giving full instructions of each stage in sequence, from the assembly of the rough material to the completed boat; together with instructions for sailing and operating.

The simplified methods of construction are those invented and perfected by H. E. Boucher, Naval Architect and Mechanical Engineer, president and founder of Boucher, Inc., Madison Avenue, New York City, the recognized leading marine model makers of the country. Mr. George Ratsey, of Ratsey and Lapthorn, Incorporated, New York and London, makers of sails for racing yachts of international reputation, has supplied the data from which the sails are made. Mr. Ratsey is also an enthusiastic and successful racing skipper.

The construction of these boats represents the highest type of the model makers' art, and would ordinarily be difficult for the amateur to build but for the fact that the author was given permission to study the Boucher simplified construction methods. Through this book you will receive the same instructions that are given to apprentices in marine model making in the shops of Mr. Boucher's company.

One cannot take the design of any successful large racing yacht and make a scale reduction of it expecting to produce a successful miniature sailing yacht because of the law of relativity in mechanics. This translated into understandable language is as follows:

Sails have two dimensions, length and breadth; we speak of them in terms of square feet or square inches. Hulls and lead keels have three dimensions, length, breadth and depth; we speak of them in terms of cubical contents. Consequently if we attempt to reduce both sails and hulls in an exact scale reduction we are in reality reducing the sails by the square (which is correct) but the hull by the cube (which is one power too much). This gives a boat with too much sail for the size of the hull and lead keel, and the result is a boat that will not stand up properly in the water. What is necessary is to increase the amount of lead in proportion and then we must increase the size of the hull in order to support the increased weight of lead. In reality a complete new calculation is made to determine the size of the hull and lead to balance the scale reduction of the sails.

The use of tools is learned in making a box, but after the box is completed, the interest ceases. Not so with a boat, several boats of the same class may be raced and naturally the best boat and skipper will win. But the boat that does not win at first may be altered slightly to improve her speed or sailing qualities, thus increasing and prolonging the interest. Model races are frequently held on the lakes of many city parks and these races are sometimes international affairs which are usually held under the auspices of the National Model Yacht Racing Association.

The saucy racing craft shown in this book (sailing models) are fitted with automatic steering arrangements, described in detail later, by which the steering gear may be so set as to cause the boat to tack back and forth against a head wind and nearly strike at a given point

on the far side of the lake, some half mile or so away, without having been touched by the skipper, who usually follows in a light rowing skiff. In addition to the full description and cuts which make clear every detail of each boat, one will find the name of the firm where each and every part and fitting may be obtained either partly or completely shaped.

In the case of the power plants and boat fittings, no part will be indicated which is not manufactured regularly. One may obtain the parts either in rough castings, finished castings or completely assembled units. Thus there is no excuse for a builder, no matter how inexperienced he is, for not turning out a good boat. The proper nautical terms have been used throughout the book and yet it will be possible for the layman to "hoist it aboard" because in the chapter "Definitions and Nautical Terms" every word not commonly used in lay language has been completely defined.

The Author.

April, 1928.

MINIATURE BOAT BUILDING

CHAPTER I

MODEL MAKING

Manual training, taught in nearly every school in the country, has enabled the boy who wants to make something, to gratify his wish. A real boy usually wants to make something which will go, and the more it looks and acts like its full-sized prototype, the more his interest is aroused.

Model making is divided into many different classes. Some models are made of objects in real life, reduced in exact proportions, and are used for educational and demonstrating purposes, advertising, or for recollections and associations. Models are also frequently made to demonstrate a principle or for experimental purposes, before the full-sized structure or object is undertaken. Other models simply represent the object as it appears from the outside, the interior being solid and unfinished. The most interesting of all models are working models and it is of this type that we are about to learn.

Scale models are those which represent an actual reproduction in miniature of the real object. For instance, a model made on a scale of one inch to the foot, means that every inch of the model measures one foot on the original object. The model is one-twelfth the size of the object. A quarter inch scale model is one forty-eighth the size of the object, and so on. Every part is made accurately to scale.

It is well for a man to have a hobby, for a hobby takes the mind from hum-drum, everyday life and permits complete relaxation. A story is told of a man, his name matters not, who came home nights and worried about his business to the extent that he was bordering on nervous prostration. A long vacation, a trip and a lot of other things that cost money, were suggested, but somehow he did none of them; instead he found a hobby and now he spends many of his spare evenings making models. He was amazed in a short time at the skill he developed and the excellent work he turned out. His threatened breakdown is quite forgotten and he is himself once again.

You may ask why this man did not build something useful and here is the reason. John Ruskin, in 1870, observed some athletes training, and suggested that they be put to work on something productive, but this was a complete failure—the fascination was gone when they undertook regular work. And so it is with a hobby, it must be something in which there is pleasure. We do it because we want to and because we like it.

Model making had its origin many years ago, before the time of our present day naval architect. Master shipwrights, as they were then called, were responsible for the grace and power of the former "monarchs of the sea." For every vessel which was built, a scale model, perfect in every detail, was made. From these models the ship was built. In those days, models took the place of the plans which our present day naval architects develop.

Most of these models, in fact nearly all of the models of famous old ships made abroad, may be found in the museums of the countries in which they were originally built. These models are, of course, not working models, but were used primarily for construction purposes. After the vessel was completed they were kept as records.

Later on, when the art of drafting was developed and naval architects came into being, plans, in many cases, took the place of models, but to this day one of the first things that is done in a scientifically built ship, after the contract lines are developed, is to prepare a model, usually about 15 or 20 feet long, of the entire hull. The model is weighted until it is down to the proper designed draft of the vessel it represents, and is then towed through the water by a delicately arranged device that registers the pull to the smallest fraction of an ounce. Tests are made at different speeds. This is done in an experimental model basin, to ascertain the exact amount of horse power necessary to drive the full size vessel at a given speed. The waves which are thrown off by the model are studied and frequently these tests suggest changes in the underwater form to improve the speed or sailing qualities.

At an early stage in the design of steel vessels, half models are made of the shape of the outer hull. Steel plating diagrams are laid out on these models in order that the exact size and shape of the plates may be ordered from the mill. This, of course, reduces waste.

Connections and features of the vessel difficult to

depict in drawings frequently require a model to clearly indicate them.

Frequently, models are made of proposed ships in order that stockholders of companies may see exactly the type of ship contemplated. The government makes models of ships of a proposed new type in order that Congress may see them before appropriating the money for their construction. These models are held, and they form interesting exhibits from which anyone, not skilled in such matters, may follow the development of a navy or a merchant fleet. The U. S. Navy exhibit of models forms one of the most interesting displays of its kind.

Many ship models are perfect in every detail and are made accurately to scale. A single model will sometimes cost as much as $10,000. The New York Yacht Club has a model collection valued at $250,000 and a detailed drawing of every model is filed in a fireproof safe-deposit vault. The collection is insured for the full amount. In case the models are destroyed from any cause whatever, they could thus be replaced by working from these plans. This collection contains many models of great historical interest.

Usually a working model is made of every invention and it is used by the inventor for demonstration purposes and in developing and perfecting it. Frequently an inventor has only the idea and it is necessary for the expert model maker to develop the idea until it works. Professional model makers, or those directing their activities, must be mechanical engineers, civil engineers and naval architects, in order to meet the exacting demands of their clients.

There is no end to the field of activities of a pro-

fessional model maker; and his work is no child's play. It is a steady and lucrative profession, and one interested enough in the subject to become proficient by reason of practice, need never want for employment.

The principal object of this book is to deal with the construction and operation for working models of sail and power boats which, at full size, range from twenty to one hundred feet in length. The manner of determining the underwater body and the development of the lines though is similar for either the model or full-sized craft.

Naturally, the first thing to be determined after the approximate length of the craft is decided upon, is the shape of the underwater body. This is frequently done by shaping a model by eye, based on past experience. The model is then cut into sections in order to transfer these lines to paper from which full-sized templates can be made.

The lines of a vessel appear complicated to the novice and mean practically nothing. They are apparently a lot of curved and twisted lines piled one upon the other. In reality, these lines represent one of the highest forms of engineering and they show with the utmost accuracy the form of a vessel.

Fig. 1* shows such a set of lines, in this case a simple boat, the views marked A, B, C, (Plate 1) are called the sheer, half-breadth and the body plans respectively. The sheer plan is a profile or side view of the form of the boat. The half-breadth drawing is a plan view, or as the boat would appear looking directly down on the top of it. The body plan is a view look-

* Folding plate in pocket.

FIG. 2.

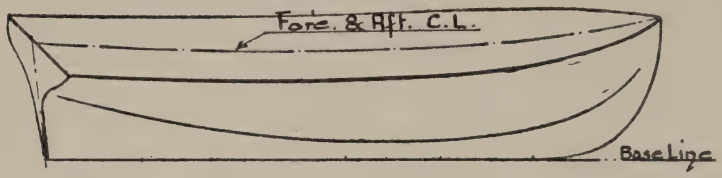


FIG. 3.

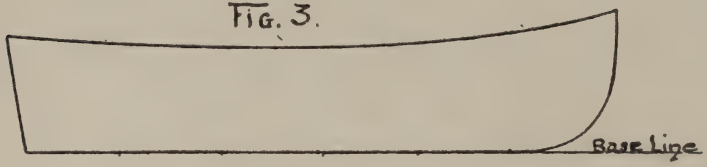
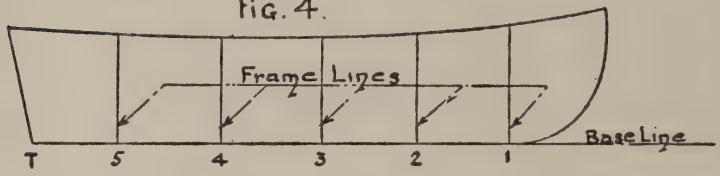


FIG. 4.



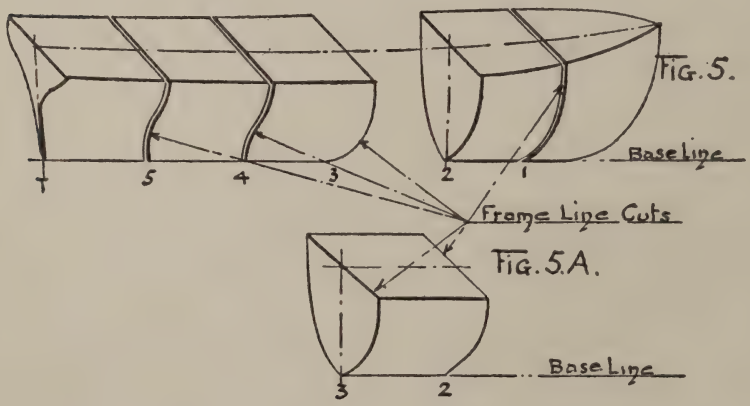
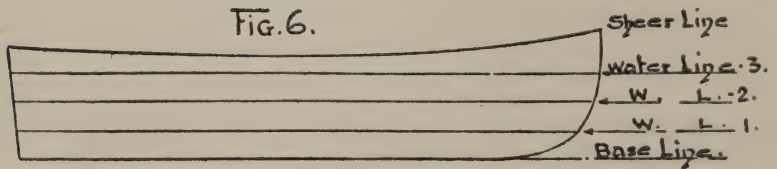


FIG. 6.



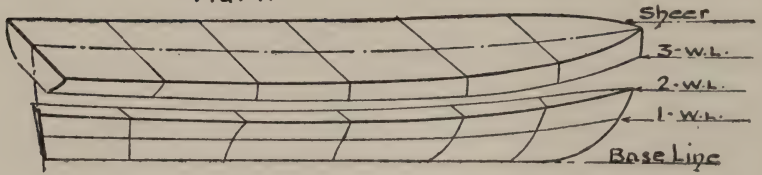
ing end-on, usually bow-on in one half, and stern-on in the other. The vertical lines on the sheer plan are frame or station lines. The horizontal lines are water lines. The curved lines are section or buttock lines.

The lines on the healf-breadth view are as follows: The curved lines are water lines, the straight fore and aft lines are section or buttock lines and the straight transverse lines are frame or station lines.

The lines on the body plan are as follows: The horizontal are water lines, the curved lines are frame or station lines and the vertical lines are section or buttock lines.

Now picture the model of a boat having the same profile and plan view and bow view as the lines drawn above. Such a model would appear as Fig. 2, and the profile or plain silhouette of this boat would appear as in Fig. 3. If we draw vertical lines, as in Fig. 4, and number them from forward to aft as shown, these lines will correspond to the frame or station lines of Fig. 1-A. Suppose we saw the boat completely through at each one of these station or frame lines, Figs. 5 and 5-A, like cutting slices of bread from a pointed Vienna loaf. If we place each slice commencing with Number 1, flat on a piece of paper to the right of the view of the profile, the lowest point of the keel exactly on the base-line and a vertical center line to the right of the profile, and trace around the slice with a pencil, for convenience just marking the half to the right of the center line, and we do this with each successive slice back as far as frame No. 3, we then have a set of frame lines for the fore-body of the boat. This is similar to the right hand side

Fig. 7.



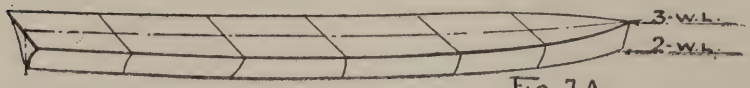


Fig. 7A.

Fig. 8.

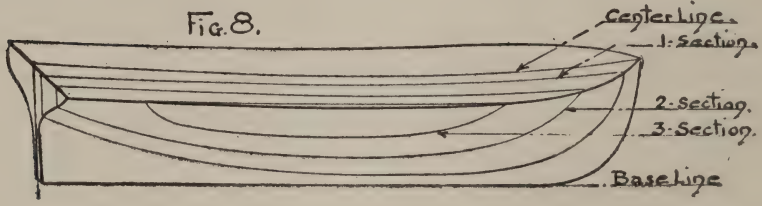


Fig. 9.

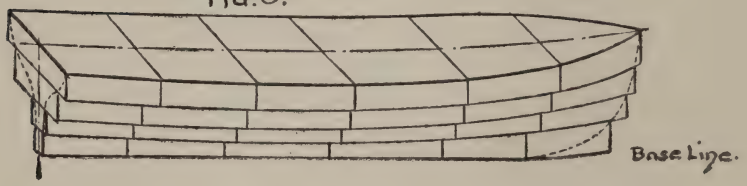
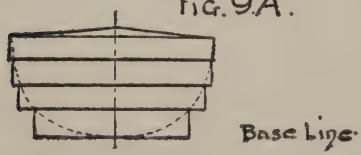


Fig. 9A.



of the body plan of Fig. 1-C. If we did likewise for the frames from No. 4 aft, but traced this half of them at the left side only, we would have all the curved lines of the body plan. Let us suppose the model is put together again and we then mark a set of longitudinal lines on the profile as in Fig. 6. These would be water lines. If we sawed the boat completely through lengthwise on each of these lines, Figs. 7 and 7-A (the latter figure is a slice, or lift, removed), just like one would cut long lengthwise horizontal slices from a Vienna loaf of bread, and lifted each slice off one at a time, placing them in their proper locations with respect to the fore and aft center line and also the frame lines and then traced with a pencil around their entire margin, we would produce a set of water lines, half-breadths. These would be similar to the curved lines shown in the half-breadth plan of Fig. 1-B. Then if we put the model together again and this time we mark a series of fore and aft lines on the top of the model as in Fig. 8, and saw down through each of these, each cut being parallel to the vertical and fore and aft center line of the boat and one cut the center line itself which divides the boat in halves, and laid one half aside, the side view of the middle cut corresponds to the profile of the boat, (the outline of the sheer plan), and the next cut outboard from the center line would correspond to the No. 1 buttock or section line in the sheer plan and so on for each of the several section lines of the model. If we take all these last slices and place them back in their original positions and then look at the boat bow-on, each of these cuts will present a vertical line. These are the vertical lines

shown in the body plan, Fig. 1, numbered 1-2-3, etc. If we turn the boat top-side up, bow to right, and look down on it, we see a number of parallel longitudinal lines. Those are the straight fore and aft lines, (section lines), seen on the half-breadth plan. If we had put the horizontal water line cuts all back in their proper locations before we put the boat into shape again, and had viewed it from the bow we would have seen a series of horizontal parallel lines or cuts similar to the water lines of the body plan, Fig. 1-C.

The lines of a big boat may appear more complicated but that is just because there are a great many more of each type of line, in order that the ship may be more accurately faired, but do not be confused, the principle is the same.

In making up a solid or cut out model, the water lines represent the lifts and when glued up before being shaped, look like Fig. 9 and Fig. 9-A. When the steps are shaped and faired the model takes its true form as indicated in dotted lines, Fig. 10-A.

One more point about the set of lines. Take section line 3 on the profile plan, Fig. 1-A. Notice the point where it crosses frame or station line 4; measure this height above the base-line, mark it on a strip of paper. Now, if you turn to the body plan, Fig. 1-C, and hold these two spots on section line No. 3, the bottom point on the base-line, you will see that the top point exactly touches where frame line 4 crosses it. Trace the intersection of any of the lines on any of the views and then turn to any one of the other views and you will see the spots correspond in height or half-breadth, as the case may be.

Now that we know something about boat lines, sheer, half-breadth and body plans and how the water lines represent horizontal slices which may be cut parallel to the floating line of the boat, and from forward to aft, and usually at equal distance apart, we know the frame lines represent transverse slices, cut at right angles to the fore and aft center line of the boat. In boat model making we use the water lines and the frame lines almost exclusively. Usually the water lines represent the lifts and the frame lines are used for making templates to check the amount of cutting and trimming that should be done in order to fair up the model when the square edges are being cut from the lifts.

Assume that you desire to build a block model from a set of lines you had developed or obtained, the procedure would be as follows: You would first decide how many lifts you wished to make, naturally the greater the number of lifts, the more accurately the lines may be followed but this also means considerably more work. In most cases lifts one inch thick suffice, and frequently, in toy models such as model sailing boats, etc., two or three wider lifts suffice, providing there are four or five frame templates from the body plan to check the shape.

For the purpose of illustrating a specific case, we will proceed to transfer the lines of Fig. 1 to a block model. We will assume 6 lifts or water lines and 8 transverse templates or frame lines. We will say the water lines are spaced 1 in. apart and the frame stations 6 in. and 3 in. apart. The complete model will be 42 in. long by 7 in. wide and 6 in. deep, consequently one must have 6 clear grained, well seasoned, kiln-

dried, pattern-makers', white-pine boards 1 in. thick, each 44 in. long by $7\frac{1}{2}$ in. wide, smoothly dressed on both sides. Draw a fore and aft center line with a sharp pencil, on each lift on the center of the $7\frac{1}{2}$ in. face and lay out the frame stations at the proper spacing and at right angles to the fore and aft center line on each lift. On the frame stations, spot the half width of the water lines on each lift exactly as they

Fig. 10.

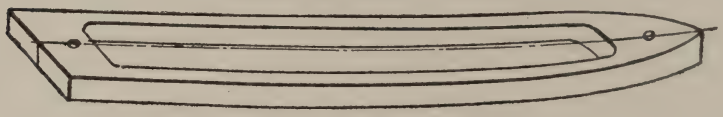
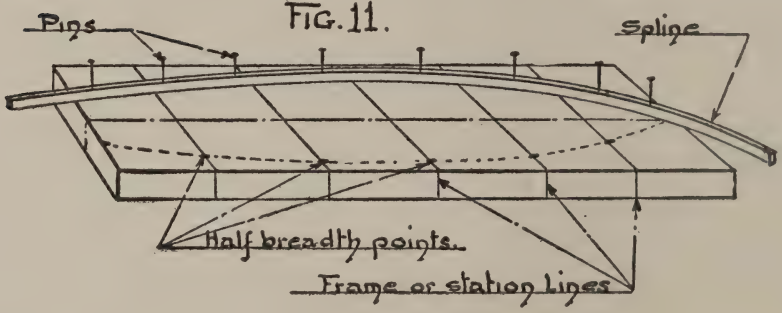


Fig. 11.



appear on the half-breadth plan, Fig. 1-B*, and connect these spots with a spline and pencil. The spline is a flexible wood strip, planed smooth, and about three-sixteenths of an inch square at its largest point, (the center), tapering to about one-sixteenth of an inch at the ends. Naval architects use these splines in connection with ship weights which hold the splines in place, to draw in water lines, sheer lines or in fact any kind of a curved line. I do not suppose you will

* Folding plate in pocket.

have any ship weights and so after you place the edge of the spline on a point, drive a pin slightly into the material to hold the spline in shape. See Fig. 11.

After each of the several lifts has had its particular water line transferred to it, the wood should be cut out neatly, nearly to the line, with a compass saw and then planed smooth to the line.

After each lift has been cut and placed one upon the other in proper place with respect to frame stations, and each fore and aft center line directly above the other as Figs. 10 and 10-A, the next thing is to hold them there in one fixed mass. This is done by glueing with water-proof glue and dowels. If the boat is going to sail or be power driven we want it light, consequently the inside is usually hollowed out. Usually before the lifts are glued up permanently, they are cut out, as indicated in Fig. 11, with a compass or scroll saw. They may be hollowed further when the entire model is glued up.

To make a good glue joint is an important thing. We recommend for water-proof work Casine Glue, sometimes called "Stickall." This comes in a white powdered form similar in appearance to malted milk. It should be mixed in cold water to the consistency of fairly thick cream. It must be mixed thoroughly in a small coffee cup, with a wooden paddle, until all of the lumps have disappeared. It should then be left to stand for fifteen minutes and finally stirred a little more. This glue must be made fresh each time and should not stand for more than one hour. Therefore make it in small quantities.

In gluing lifts, it is best for the beginner to glue one at a time and let the glue harden before starting an-

other. Spread a thin sheet of glue on each of the two faying surfaces of the lifts, rub it into the pores of the wood with the wooden paddle and then spread another thin layer and quickly place the surfaces to be glued together and clamp them securely. Remember the more pressure you apply, not up to the point of crushing the wood, the better joint you will have. Allow it to remain in the clamp for at least 8 hours. The same procedure is followed on the other lifts. In gluing up, large "C" clamps may be used, or joiners' wooden screw clamps. In fact any form of clamp where considerable direct pressure may be had, will do the work. If you use "C" clamps, place a piece of wood between the work and the clamp to prevent the latter from denting the lift.

Remember, in all kinds of gluing, no matter what kind of glue is used, the joints hold best when an even amount of glue has been applied completely over the entire faying surface. They should be clamped together with enough pressure to force the glue into the pores of the wood and the surplus out at the sides. Use a sufficient number of clamps.

When timber is first cut it is full of sap and moisture; well seasoned wood is kept for a considerable time in storage to allow some of the moisture to be eliminated. During this process the wood shrinks and sometimes cracks. Pattern-makers' kiln-dried, white-pine is wood that has been allowed to naturally season for a long time and is then sawed into boards and baked at a fairly high temperature in a dry, heated compartment. This removes the last vestiges of moisture. The best part of the wood is then cut out and the patterns or models made from it. Articles

made from this wood do not shrink or crack, but just as soon as they are completed they should be given some sort of a preservative or priming coat to keep the moisture out.

This wood is more expensive than common wood, but it is the proper kind to use in connection with model making. This wood is always specified by professionals.

Three-ply birch veneer is mentioned in the construction of some of the models and where arrangements have been made with firms to supply semi-shaped parts, the water-proof variety has been specified. This veneer is glued up with Casine Glue. The process is as follows: Three thin layers of wood are employed, the top and bottom layer have the grain running leigthwise, and the middle layer has its grain running crosswise. This material is glued in hydraulic presses and when finished, will not split or twist, although it is only three-sixteenths of an inch thick. It is hard, and difficult to cut with anything but the sharpest tools. The best way to cut a veneer board is to deeply score it on both sides with a sharp knife, using a ruler to make a straight cut, then hold it over the edge of a board and give it a quick push. A curved cut out, or a curved outside cut must be made with a sharp, fine toothed scroll saw, nearly up to the line and then planed or sandpapered down. One must be careful in using a plane because it is apt to fray the outer surface of the veneer.

To steam bend this veneer to any desired shape, use a clean paint brush and thoroughly wet the veneer on the outside of the curve and iron the inside of the same with the round edge of an iron heated just

enough not to burn the wood. By repeated wetting and ironing the veneer may be bent to fit over any curved surface of a boat's frame, the theory of course being that the hot iron draws one side and the water expands the other. Keep up the ironing process until the wet side is completely dry, then most of the curve will remain in the sheet, at least long enough to allow a builder to secure it in place to the frame.

Frames, clamps and chines are usually steam bent, in amateur work, by boiling the stock for fifteen or twenty minutes in a long shallow pan or a deep boiler, and then when they are still hot and steaming, by bending them over a form of the desired curve and then allowing them to completely dry. In professional work these parts are usually given a slightly greater curve than required, because in time they lose a little of the set, unless immediately worked into the boat and held in place with the other members.

In bradding or nailing, do not drive so many fastenings that you split the wood and refrain from driving a lot of fastenings close together and in the same line with the grain of the wood. Stagger them slightly. It is always well to drill a hole (pilot hole) with a drill somewhat smaller than the fastening, completely through the first piece to be joined and slightly into the other member so there will be no tendency to split the material. Before driving a screw, drill a pilot hole a little smaller than the diameter of the screw and then use a countersink bitt for boring the countersink for the screw head to fit it. Put a small quantity of soap on the screw and it will drive home much more easily and the countersink head will pull down, leaving a flush job.

Always, before gluing or securing anything in place, fit it well and clamp it temporarily. If it fits perfectly, then drill several small holes and drive several brads part way in. When removing the work to apply the glue, leave the brad points sticking through the work. These will serve as guides for quickly locating the proper position of the piece. This is valuable when you are in a hurry to clamp up for gluing and for permanent holding.

If one follows the practice of using small brads or screws and takes the precautions outlined of drilling guide and pilot holes, the danger of splitting a piece on which considerable labor has already been expended, will be eliminated. Care should also be taken in glueing, to make sure that the glue is smooth and free from flakes or other hard particles that might prevent perfect adhesion of the pieces to be joined together.

CHAPTER II

MODEL YACHT DESIGN AND SUGGESTIONS FOR SAILING AND SAIL MAKING

The fundamentals of model yacht design are a complex subject and one that would fill a good size book. It is the purpose of this chapter to deal with the subject in lay language and only to the extent of giving the amateur miniature yachtsman a sufficient knowledge to enable him to prepare a design that will step along like a regular boat and not turn turtle or otherwise disgrace him.

The writer is not conducting a class in naval architecture in which problems of stability, displacement, righting arms, moments and the mathematics pertaining thereto are to be treated upon, but simply citing some of the elementary problems that will tend to help the amateur.

The displacement of a boat is the quantity of water that is pushes aside or displaces when at rest. You will better understand it this way. A boat, when placed in water, sinks to a certain depth and the remainder floats above the water. If it were possible to freeze the water around the boat and then lift the boat out, you would find the exact shape of the boat's underbody in the ice; now if you filled the cavity in the ice with water just level at the top, and then poured this water out and weighed it, you would find it tipped the scale at exactly the same weight as the

boat at the time it was placed in the water. Hence, a boat or any floating body displaces its own weight. For this reason a narrow, sharp boat sinks deeper in the water than a somewhat broader one of the same weight. A fairly shallow draft boat frequently has less of its surface exposed in the water, consequently there is less skin friction and the boat is faster.

Experience and calculation of course is necessary to determine a happy compromise between a boat that is too broad and flat and one that is too sharp and narrow. An absolutely perfect compromise, in order to obtain an ideal condition, can only be had by development and actual test.

A log of wood tows through the water best with its large end first. It was this knowledge that made our original Yankee clipper ships so fast.

A solid log twelve inches in diameter and thirty feet long tows harder than the same size log when it has been hollowed out and the ends plugged to keep the water out. There are two reasons for this, the solid log weighs more and sinks deeper, causing more of its surface to be exposed to the water. There is a certain amount of resistance in pulling an object through the air and a correspondingly greater resistance in pulling the same body through the water. This is called skin friction or resistance. Boats are made hollow in order to give them more room inside and to make them lighter. The ship's underbody is so shaped as to minimize skin friction and cause the least amount of water disturbances. The latter are a source of lost power or effort.

Sailing boats, particularly racing craft, must be light, fairly broad and shallow, with a weighted keel,

or pendulum, down low to give them stability and to compensate for the enormous amount of sails they carry in order to keep them from capsizing in the wind. Therefore the center of gravity of a boat must be below the line of flotation in order to keep her from turning over. This is done by making the upper portion of the hull as light as possible and attaching a fin keel and weight to the under portion.

In a power boat the designer needs only to figure on the boat and machinery weights, but in a sailboat there must be an extra margin of weight below the line of flotation to balance the pressure of wind upon the sails. This is the reason for the fin keel with the lead bulb at the bottom. If you took a thin board, say two feet long, six inches wide and $\frac{1}{4}$ in. thick, and balanced it upon a knife edge as indicated in Fig. 12, and placed weights on the left of the knife edge to represent the pressure of wind on the sails, the knife edge representing the line of flotation of the boat, the portion of the board to the right of the knife edge representing the part of the boat in the water, you would find it necessary to place a certain amount of weight near the extreme right hand edge of the board to balance it on the knife edge. In a boat you would add a little more than just enough to balance the right hand weights to be safe. This excess is called the "righting arm" or the force that tends to keep the boat in an upright position against the pressure of the wind on the sails.

A sailboat must have a keel or centerboard. These give her "lateral resistance" and the pressure of the wind on the sails acting against the keel or centerboard cause the boat to run ahead through the water

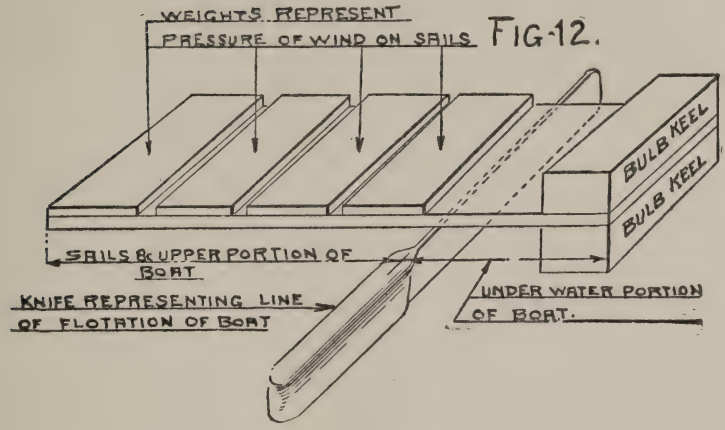
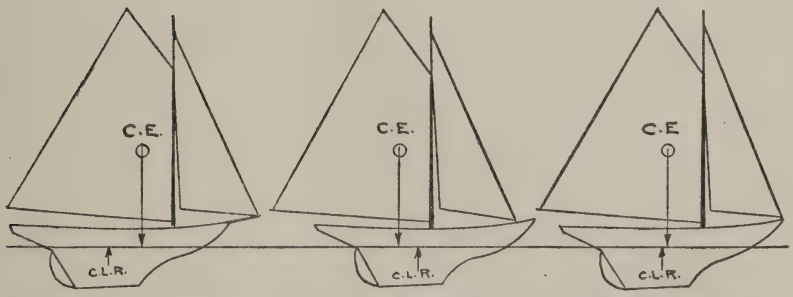

WEIGHTS REPRESENT
PRESSURE OF WIND ON SAILS
BULB KEEL
BULB KEEL
SAILS & UPPER PORTION OF BOAT
KNIFE REPRESENTING LINE OF FLOTATION OF BOAT
UNDER WATER PORTION OF BOAT.

FIG-12.



C.E. TOO FAR FORD. BOAT WOULD FALL OFF (INCORRECT)

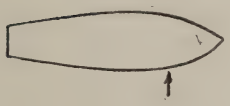
C.E. TOO FAR AFT, BOAT WOULD HEAD INTO WIND (INCORRECT)

C.E. SLIGHTLY FORD. OF CENTER OF LATERAL R (CORRECT)

FIG. 13

FIG. 14.

FIG-15.



and not slide sideways. It will be seen from this that the area and shape of the sails must be such that the boat will be balanced against the pressure of the water on the lee side of the hull.

In a properly designed sailboat the center of gravity of all the sails should be slightly forward of the center of gravity of the under water hull. If you cut a piece of cardboard the exact shape of the profile or silhouette of the under water hull and balance it horizontally on a pin point the spot on which it balances is the center of gravity or, as it is termed, the center of lateral resistance of the hull. Likewise if you make a cut-out in cardboard of your total sail area, main-sail and jibs combined, and balance it in the same manner, you will find the combined center of gravity of the sails or, as it is called, the center of effort of the sails.

Fig. 13 is incorrect; this boat would fall off the wind as the center of effort is too far forward.

Fig. 14 is incorrect for this boat would head into the wind as the center of effort is too far aft.

Fig. 15 is correct; the center of effort is slightly forward of the center of lateral resistance. The boat is properly designed and would have a slight tendency to come up into the wind.

Power speed boat hulls differ from sailing hulls to the extent that the former usually have hard bilges and comparatively flat bottoms, while the latter have round bilges and soft round lines. The reason for this is that sailboats scarcely ever sail without a list, they are heeled over considerably by the wind and they must present a fair, easy run, and a good entering section at each different angle of list. While a

power boat, after she attains her maximum speed, remains on practically the same water line.

The ratio of length to beam of the average miniature power speed boat of today is about 4 to 1. That is a boat of 36 in. in length would be about 9 in. wide.

Due to the considerable amount of machinery carried in speed boats the hulls must be designed as light as possible consistent with strength. Hence the framed up type or the well dug out block type with veneer sides.

The wetted surface of a racing power boat is considerably less when at speed than when in a static condition. This is what is called planing. Their powerful motors actually drive the boat up out of the water. The sharp V-bottom forward gradually flattening toward the stern, tends to climb up out of the water and run on the surface until the keel is uncovered for at least one-third of the length. Naturally this reduced wetted surface with the resulting reduction in skin friction is what gives this type of boat its enormous increase of speed over the old displacement boat that was narrow and sharp but did not rise when at speed. The principal weights of the present day speed boats are placed aft of amidships in order to assist the lifting of the bow.

What actually happens when speed boats are running their best is as follows:—The sharp V-section of the boat at about one-third the length from the bow cleaves the water, when the boat is lifted to this point, and breaks it up into little globules of water and air mixed, and the remaining two-thirds of the boat remaining in the water rolls along over this mass in a manner similar to a board on which one might

stand after the board was placed on a number of marbles. The friction that would ordinarily hold the board, if laid flat with all of its surface touching, would be thus largely removed. This is the type of hard bilge, V-bottom, gradually flattening aft, that has been given to the speed boats mentioned in this book. There must be no quick lumpy changes. The bow must be rather full and well rounded, with easy, graceful bilges for sailing boats and hard bilges for power speed boats.

The amount of lead bulb to provide on a sailboat and the distance below water to place it in combination with a known sail spread is a matter of calculation. Naturally a designer does not want to use any more lead than necessary because that would be carrying unnecessary weight and he does not want to place it down too deep because that would increase the draft of the boat and probably have a bad effect on its steering and maneuvering qualities. The depth and weight of bulb keels of these sailboats have been so thoroughly calculated and tested that it is not believed any change can be made to improve them. The exact amount of lead and the exact shape which actual test has indicated to be correct, is specified on all the boats shown in this book.

The subject of model sail design and model sailing, it is believed, will be best understood by a description of the development as well as that of the shape and proportion of sails.

Running before the wind, or in the direction of the wind, appears to be the simplest form of sailing. Any object erected above the top-side deck, in which the wind may catch, will accomplish this result. Obvi-

ously, the lighter the object, the larger it may be in order to catch the maximum amount of wind, and at the same time it may be more easily adjusted in order to sail in directions other than that in which the wind is blowing.

The simplest form of conventional home-made boat and sail is a flat board pointed at one end, into which one or more sticks or masts have been driven and upon which have been mounted sheets of writing paper for sails as indicated in Fig. 16.

This saucy ship of our first creation goes quite well with the wind. But try and sail her into the wind or at right angles to the same. The boat refuses to go ahead, and simply slides sideways or blows backward.

When man first learned to sail he could only navigate in the direction of the wind, but he soon learned to place a plank on edge in the water at the side of his boat to prevent the craft from sliding sideways when the sails were trimmed at any angle other than at right angles to the direction from which the wind was blowing. This was done in order to sail in a direction other than with the wind. The board was finally called a "lee-board" and is used to this day on canoes and certain other types of boats.

If we take a flat-bottom, shallow-draft boat and mount a great high mast and sail on it, and place it in the water so the wind hits the sails sidewise, and the sails are trimmed any number of degrees off center, in a fore and aft rigged boat, there must be something extending down into the water from the bottom of the boat to resist the side push of the wind on the sails. This object should cause as little fric-

FIG-16.

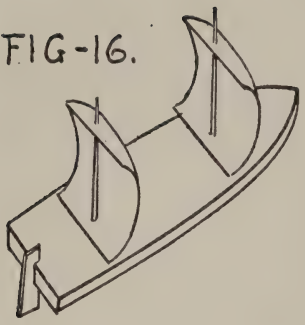


FIG.-17.

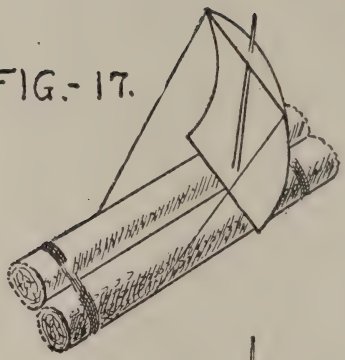


FIG-18.

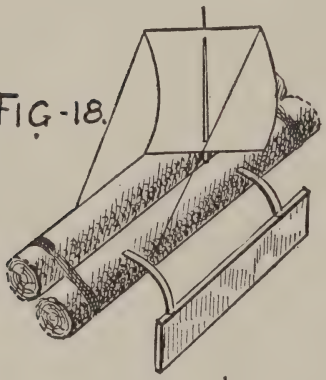


FIG-19.

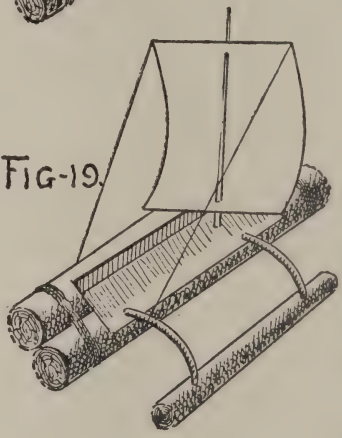


FIG-20.

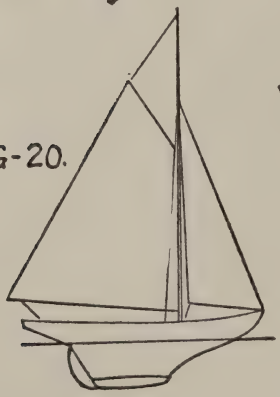
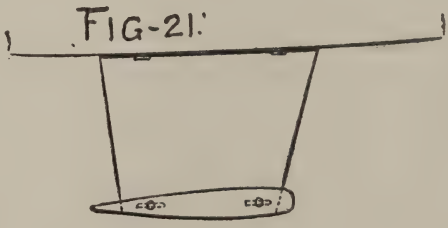
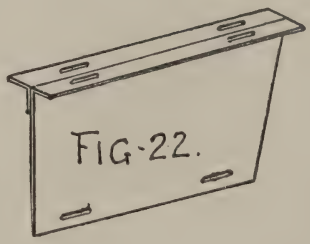


FIG-21.





tion as possible and be heavier at the bottom than at the top.

Water is denser than air, consequently the protrusion need not be as great in area as the sails in order to resist the wind pressure to the correct degree.

On can readily follow the different stages that were gone through by man in learning to sail. **First:**—Some kind of a grass mat mounted upon a pole; the boat was probably a log or two logs lashed side by side as Fig. 17. The sail could not have been very high or the "boat" would have capsized. It could only sail in one direction, with the wind. **Second:**—A lee-board was devised, Fig. 18, and by pulling the grass mat around at different angles, the boat or logs could proceed in directions other than that in which the wind was blowing. **Third:**—A means was devised in order to increase the height and area of sails to gain more speed. This was done by hollowing out the logs or boat and placing a light auxiliary float in the water three or four feet from the boat and attached to it by sticks that did not touch the water, Fig. 19. This rig worked better when the float happened to be on the lee side. **Fourth:**—The lee-board and the side steadying floats were combined in the bulb keel. With the bulb or fin keel, Fig. 20, the height and area of the sails may be increased to nearly any proportion. It will be noted that the approximate sail area in proportion to the size of hull is considerably greater in this boat than in the boats, (log floats), not fitted with bulb keels.

With the knowledge gained through these stages it will be seen that it is now possible to construct sails to almost any size and compensate for them with a

fin keel and bulb sufficiently heavy to balance them. The more sail, the deeper the fin keel and the heavier the weight to balance the pressure. There is a happy medium, however, that experience has demonstrated to be best. If the keel is too deep the boat is apt to ground in the depth of ordinary inland waters in which it will be navigated, and if the bulb is too heavy the boat will be too sluggish and hard to push along. Obviously, there was no jump from the hollowed out logs to the rather modern racing sloop. There were many stages of development between these two efforts. Centerboard rigs came into being, but as we are not building any of this type of boat I will make no special mention of them. I wanted to show that after builders learned to compensate properly, the development was rather rapid.

The design of a suit of sails is, therefore, based largely on experience. Many interesting experiments and much valuable data may be gained by the amateur by experimenting himself. The first part of this chapter covers the theory of the compensation of sail pressure by the bulb keel and the proper location of the center of gravity of the sails with respect to the center of lateral resistance of the hull of the boat.

Take any sailboat design and construct two hulls exactly alike. Let one boy build his boat and sails exactly to the figures given. Then let another lad add a little to the sail area and increase the depth of the size of bulb, following, of course, the instructions given for finding the center of effort of the sails.

After the two boats are completed, race them together under exactly the same conditions and see which boat wins, and why. In order to be fair, they

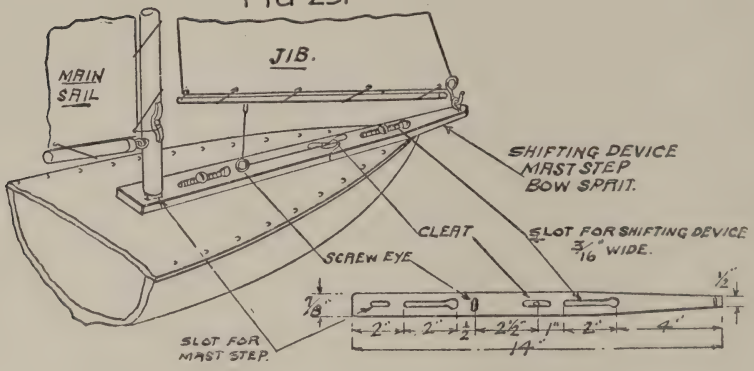
should be sailed at every angle to and with the wind several times and the average of winnings counted. Although a boat may be manifestly a better all around boat than another the poorer boat may be able to sail faster under some one or two conditions than the other, so the average will be necessary in order to arrive at a correct conclusion. The sails you use for these experiments need not be the best material and the fin and bulb may be secured temporarily in order that they may be shifted several times until the best location has been found. Figs. 21 and 22 show methods which may be employed to shift these elements, by backing off the screws the fins and bulbs may be shifted for the length of the slots.

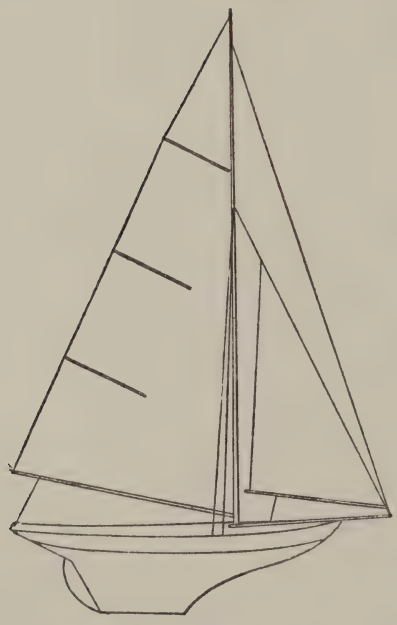
Fig. 23 is an ingenious and novel device developed and patented by Mr. Boucher for allowing the model yachtsman to shift his center of effort of the combined sail area quite some distance fore and aft, to allow for many interesting experiments and to suit different conditions of sailing. That is, you will find when sailing before the wind your boat may act better if you shift your center of effort a little forward or aft of the point at which it may do best when sailing close hauled.

Inasmuch as this feature is patented, the law forbids anyone to make them to sell except the patentee. However, no objection will be made to anyone making them for his own use on these models.

The fundamentals of the relative size of sails in proportion to the other elements of the hull and their location with respect to the same should be apparent after reading this chapter. It is obvious that the top weights, such as spars and fittings, should be kept

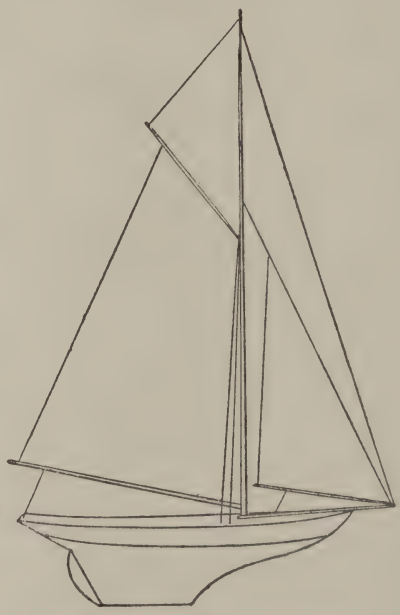
FIG-23.





MARCONI RIG SLOOP.

FIG-24.



GAFF AND BOOM RIG SLOOP.

FIG-25.

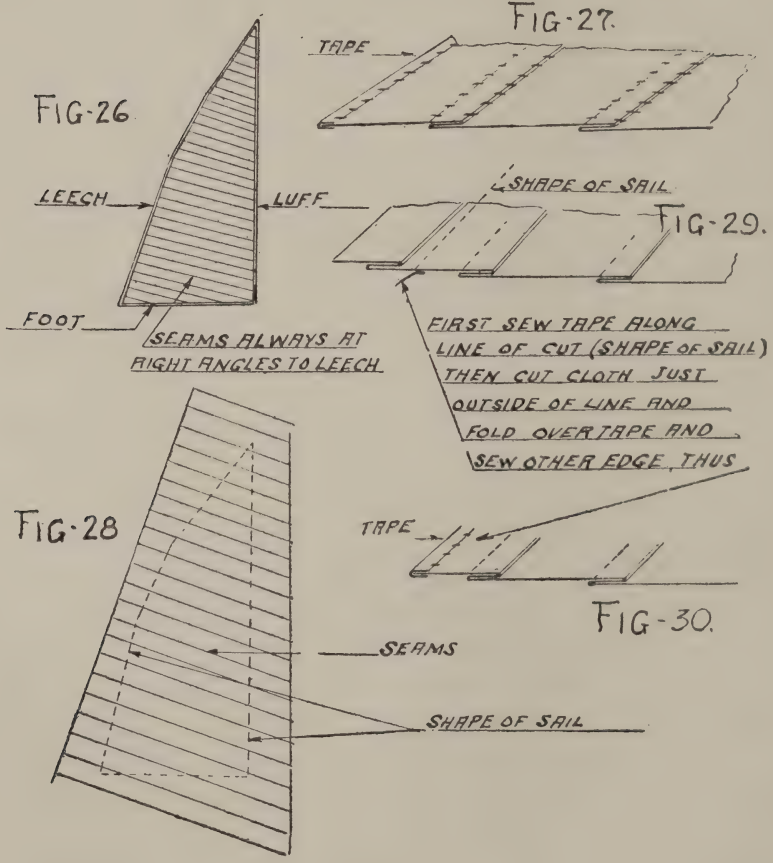
down to the minimum consistent with strength for the reason of balance.

The sails considered best and most popular for miniature boats, or rather I should say, the rig, is that known as the Marconi, (fore and aft rig). A mainsail, in this rig, combines the mainsail and topsail of a boom and gaff rig and eliminates the use and weight of the gaff. Figs. 24 and 25 indicate the difference between the Marconi and the boom and gaff rig.

A properly designed suit of sails, after the dimensions have been determined, should have a very slight slack or bag in the middle. The figures given in the book for size of sails are for the flat sizes just as if they were of tin. Frequently "store boats" have their sails made for show and not for sailing. They look better to the untrained eye if they hang nice and flat without the slightest bag. But a properly made sail if laid out flat on the sail loft floor and with the outer edges stretched out tight will show the slightest looseness in the center.

Sails for large boats are, of course, made of strips of canvas sewed together because it would be impossible to get canvas large enough for one piece. When they are made up they look like Fig. 26. In the case of models this, of course, does not follow. Some model makers, however, are so fussy that although the sails may be made in one piece they prefer to sew imitation seams in them. This is unnecessary and is only for looks. It is done by lapping over the material as indicated in Fig. 27. The sewing should be done by hand with an overhand stitch. A piece of cloth should be selected and completely stitched before the exact shape of the sail is cut out, then after the stitching is

completed the outline of the sail is carefully marked thereon and cut out. See Fig. 28. Then hand stitch a piece of $\frac{1}{4}$ in. binding $\frac{1}{8}$ in. in from the edge first on one side then fold over and hand stitch on the other. See Figs. 29 and 30. All of the stitching is by hand with a round, overhand stitch as indicated. The tape does not stretch or shrink, that is the purpose of securing it.



No exact rule will be given for the best area of sail in proportion to the hull of a racing boat. Follow the sizes given for each boat and, if you desire, experiment with cheap material, making the sails slightly larger or smaller for comparison.

The simplest fore and aft rig boats in this book are the Cape Cod type hull with a "lug" mainsail, Fig. 31, and the Cat Boat with the Marconi mainsail, Fig. 32. None of the designs here given cover the construction of a sloop or schooner with mainsail and topsail rig.

The rigging by which the sails are held in place and trimmed is as follows: Standing rigging, stays. Running rigging, halyards and sheets and their uses are as follows in the order mentioned. Ropes or wire cables which support the masts, ropes by which the sails are manipulated, ropes by which the sails are raised and the sheets are the ropes by which the slant of the sails of a fore and aft rigged boat are controlled or trimmed.

In the Marconi rig the two spars for spreading the topsail are eliminated, the sprit, or yard, and the club. These are the spars that extend the luff or the front and the foot of the topsail.

The best cloth to use for mainiature sails is balloon cloth.

The amateur yachtsman will soon learn that by the use of the patented sail shifting device, indicated in the details of the sailing boats mentioned, that he has a decided advantage over his opponent's boats which are not so fitted. Where there is no crew aboard to shift ballast and constantly adjust sails and change helm, boats with a fixed mast and consequently a

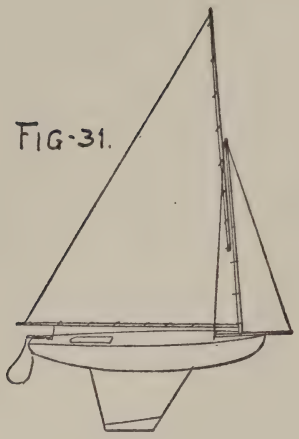
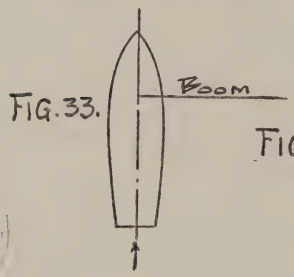


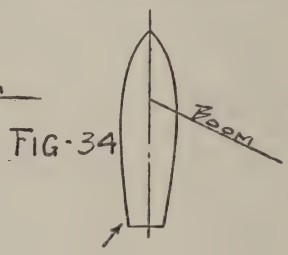
FIG. 31.

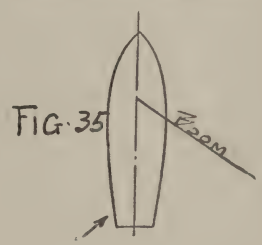
CAPE COD HULL
LUG MAINSAIL

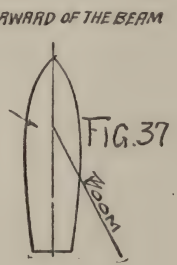
FIG. 32.

V. TYPE CAT BOAT.









fixed center of effort are under a handicap when sailing under different weather and wind conditions. Our skippers will have the advantage of using judgment of past performance of their boats. You will find that in a light wind, the entire rig should be moved aft, in medium wind the same may be moved half-way forward and in a heavy wind all the way forward. On the wind or, close hauled, sailing to windward, these boats may be perfectly balanced. The shifting must be done of course before the race, to suit the wind you find on the course. A little practice will make one quite an expert.

The following information will be of use to the miniature yachtsman although it is data intended primarily for boats operating with a man aboard but for those who know nothing of the theory of sailing it will help with miniature boat sailing. The fundamentals are the same.

SAILING

Running before the wind looks like the ideal way to sail but experience will soon teach that this is not so. Fig. 33 shows the location of the sail when on this course. Steering is difficult when running with the wind aft, especially in rough water, and there is danger of the sail gybing over when least expected. Except in smooth water, it is better to haul the boat up so as to have the wind on one quarter, and after following this course for some distance, to take the other tack, that is, carefully gybe over so as to bring the wind on the other quarter. Fig. 34 represents the wind on the quarter. Fig. 35 shows the wind abaft

the beam. Fig. 36 shows the wind abeam or directly at right angles with the boat. Fig. 37 shows the wind forward of the beam. Each figure shows the proper location or direction of the boom or, in nautical terms, how the sail should be trimmed. All of these are shown as favorable winds, the sheet being hauled in such a distance as to give the best results. The positions in all of these figures show a boat when it is what is termed sailing free.

To sail close hauled means to bring the boat up as close into the wind as possible and still keep it on its course with the wind filling the sails so as to drive the boat forward. A properly built boat will lie within four or four and a half points of the wind, while some will do even better.

Fig. 38 shows the proper location of the boom when sailing close hauled. The wind striking the sail at this angle will drive the boat forward and maintain good speed, while to haul it closer would increase the leeway until, if the sail were hauled parallel with the keel, the only progress made would be to leeward. Most boats will sail closer to the wind in smooth water than in rough.

When sailing close hauled, it is necessary to hold the boat to a course which will just nicely keep the sail filled with wind. This point can be found by pulling the helm slowly to leeward. As soon as the sail begins to shake near the head, you have reached a point where it is not drawing as much as it should, and if the helm is kept down, the sail will begin to flap in the wind and the boat will loose headway. A little practice will enable one to see the beginning of the tremble in the sail and at the first symptom he

must reverse the helm until the wind fills the sail fairly.

Any novice can understand how a sailing boat can travel with the wind, but why it goes forward with the sails close hauled is a question of dynamics and may be best understood by the amateur by the following. Take a V-shaped block of wood and press it between the thumb and forefinger. If sufficient pressure is used it shoots forward quickly. The thumb may be likened to the wind and the forefinger to the water on the opposite side of the boat. The pressure caused by the wind on the sails pushing the boat against the water on the opposite side causes the boat to go forward.

CHAPTER III

PAINTING AND FINISHING

This is where the unadvised amateur is most apt to spoil the job and many home-made models look as if the paint had been put on with a twelve-inch wall brush or a shovel. We do not want these boats to look that way so read this chapter carefully.

After the hull of the boat is completed and all brad heads slightly countersunk the first smoothing should be done with fairly smooth sandpaper and the final smoothing with 00 sandpaper until all signs of tool marks or roughness have disappeared.

When bright natural finish is mentioned it means that the work is simply rubbed smooth with sandpaper and given the usual number of coats of varnish, nothing else.

When bright mahogany finish is mentioned it means the work is rubbed smooth, then stained mahogany and then given the usual number of coats of varnish.

It is suggested that Valspar varnish be used. It is known to the trade as a compromise varnish and it is therefore considered the best for miniature boat work. Large boats that are in the water all the time, use outside varnish, but in a model this is too slow in drying. The best inside varnish does not give the proper water protection. Under no circumstances use an

inside varnish if the boat is to go in the water. The best stain of which the author knows of is Devoe's oil stain. A one-half-pint can will do for several boats.

Use the best ready-mixed paints, but you will find they are too thick for miniature boat work and must be diluted with turpentine, to the consistency of cream. Then add five drops of japan dryer to a one-half-pint of paint. Three or four thin coats, well brushed out, will be best. Each coat should be allowed to thoroughly dry and then rubbed down before applying the next.

The best paint for water protection is pure white-lead in linseed oil, diluted as above specified. If the boat is to be finished bright top-sides, with colored boot-topping and another color underbody, use the paint known as ground in japan thinned as described above. Japan paints dry flat, (without gloss) and work best after three coats have been applied and rubbed down between each coat. The boat should then receive at least three coats of varnish, properly rubbed.

If the boat is to have white top-sides, give the entire boat, except the deck and spars, three thin coats of flat white, (lead and oil diluted as above), before applying the bottom paint and varnish.

When the paint or varnish is applied with a brush, no matter how soft and good the brush is, no matter how carefully the work is kept out of the dust while drying, uneven surfaces will result from brush marks. It is customary therefore after each coat is thoroughly dry and hard to lightly rub it to remove unevenness and finally to polish. Paint or varnish

should both be applied in thin coats well brushed out.

After the first coat, let it thoroughly dry and harden, then rub it lightly with 00 sandpaper, (do not cut through), and brush off and apply the second coat, allowing it to thoroughly dry and harden. Then rub down with powdered pumice stone and crude oil, using a $\frac{1}{4}$ in. thick felt pad 2 in. by 4 in. long. After the third coat repeat this process. After the fourth coat, which is a flowed on coat in the case of varnish, rub it with powdered "rotten-stone," oil and a felt pad. Finally polish it with dry "rotten-stone" on the palm of the hand. Wipe the work clean and dry with cheese cloth after each rubbing and before applying a new coat. When rubbing down, rub in one direction, that is, back and forth with the grain of the wood and not in a circle.

The utmost care is to be taken to keep the work out of all dust while the paint or varnish is drying.

After using a good varnish or paint brush, which should be a rubber set, or equal, flat brush about 2 in. wide, it should be cleaned immediately in gasoline and finally in warm water and soap and then hung up to dry.

The purpose of paint and varnish, besides the decorative features, is to preserve the wood and to keep the water from swelling and loosening the joints.

It is advisable to give the inside of the boat two good coats of pure linseed oil and one or two coats of some light colored paint. Do not rub this down.

In applying mahogany or any other stain be careful not to smear the surrounding wood work. Paint it on with a small brush and when it is nearly dry rub off

the extra pigment with a piece of cheese cloth. If it is not dark enough, apply another coat and rub it off as before. Then when the stain is thoroughly dry apply the varnish. Do not rub down the stain until it has received one coat of varnish. Be sure not to cut through or you will leave a light streak.

In some woods, such as oak and ash, and sometimes mahogany and birch veneer, the grain is so open that a paste filler is rubbed in after the wood has received one coat of stain. The paste filler is cheap and comes in small cans, plain white; it is customary to color it considerably darker than the stain being used, except for plain bright finish where it is used white. A small quantity is colored and made the consistency of very thick cream and then rubbed over the wood. It should be worked into the pores and allowed to nearly dry. Then it is rubbed off, the idea being to only leave the filler in the pores of the wood. This helps to smooth up and to give the work a rich appearance by coloring the pores a little darker than the remainder of the work in dark stained woods. Allow the filler to dry several hours before applying the varnish.

If you have built a veneer sided power speed boat it looks best with bright natural finished deck, bright mahogany finished top-sides, coamings and beading, bright yellow boot-topping and robin's egg blue bottom.

The birch veneer grain is particularly adapted to take a good mahogany stain and when finished it can hardly be distinguished from mahogany.

The specific procedure for finishing a birch veneer power boat is as follows: Bright deck, bright mahogany finished top-sides and coamings, yellow boot-

topping, robin's egg blue underbody. Of course any other desirable colors may be used.

After all surfaces have been rubbed down with 00 sandpaper, and also dusted off, apply mahogany stain carefully to the top-sides, beading, coamings and transom. Be careful not to smear the deck with the stain. Stain the transom for its full depth and the sides aft as deep as the transom and forward to about one inch below the chine line. In other words to just below the water line. After the first coat of stain is dry, putty all brad heads with putty colored with the stain. Follow the previous directions for staining.

The next step will be to determine exactly how deep in the water the boat will float when loaded or, in case of a sailboat, when fitted with spars and sails. If machinery or sails are not fitted, place them in the boat in their exact location and place the boat carefully in the tub of water. After the boat and water are quite still, sprinkle a little powdered charcoal in the water near the boat on both sides. The charcoal will be attracted to the sides of the boat and will mark clearly the exact water line. Take the boat out of the water immediately. Let the boat thoroughly dry as paint applied to a damp surface will not hold. Then with a soft, sharp pencil and a flat spline, lightly mark in the line of the charcoal. This will be the exact water line. Then mark another line about $\frac{3}{8}$ in. above the water line at the transom and $\frac{3}{4}$ in. above the water line at the bow. This narrow strip, slightly wider forward than aft, is for the boot-topping; mark it in lightly with a spline and pencil.

The top and bottom boundary of the boot-topping is now marked in. Use a drafting pen and the spline

to mark in the paint line or, if you have a steady hand, run the top line in with a flat striping brush. Work the color down to just below the water line, rubbing it out well, particularly at the bottom, to prevent a ridge between the lower boundary of the boot-topping and the upper boundary of the underbottom paint when the latter is applied. Apply boot-topping as previously described and with japan paint.

After the proper number of coats of this have been applied and rubbed down and the last coat is dry, again place the boat carefully in the water and sprinkle charcoal to locate the water line that has been obliterated by working the boot-topping color down below the same. After the boat is out of water and dry, trace in the line and proceed to paint in the bottom color, (japan paint), as previously described. After the necessary number of coats have been applied and rubbed down we are now ready to varnish.

The boat is now stained mahogany top-sides and coamings, the boot-topping and bottom finished in flat color; the deck is plain white, unfinished wood, (birch veneer). Dust it off thoroughly and varnish the deck but do not varnish the coamings. Turn the boat bottom side up, resting it on the coamings, and then varnish the top-sides and bottom. The entire boat is now varnished except the coamings. KEEP IT OUT OF THE DUST. I usually make a temporary rectangular wood framing and cover it with some old sheeting or some other hard material that has no lint, the fabric of which is fine enough to allow air but not dust to enter. This frame is just like a box with no bottom, simply turn it upside down over the boat and leave it there until the paint or

varnish sets, that is until the dust will not stick to it. Then remove the frame and allow the finish to harden in the air of a fairly warm, dry room. Give the usual number of coats of varnish and apply as previously described. The coamings may be varnished after other parts of the boat are dry and finished.

It is customary for the name of the boat, in the case of speed motor boats, to be gold leafed on the transom and also on the deck forward. The letters are usually placed on both the port and starboard sides, about half an inch inboard of the beading and the first letter about four inches from the bow if the name is not too long. The bottoms of the letters to be parallel with the sides of the deck.

This highly professional finish will add only about fifty cents to the cost of the boat and you will probably have enough gold leaf and size left to do a dozen more boats. Bright yellow paint may be used for the name by those who do not want to use the gold.

Apply the gold leaf as follows:—After the second coat of varnish has been rubbed down and cleaned, fold a piece of paper over the deck forward and mark the shape of the deck with lead pencil. This will give you the pattern of the deck. Carefully print the name, with lead pencil, in black letters, Figs. 39 and 40. Then transfer this to the deck by slipping a piece of carbon paper, carbon side down, on the deck. Place the paper pattern of the deck, on which the name is printed, carefully in place and trace over the letters with a sharp lead pencil; this will transfer the letters to the boat. Carefully wipe off any carbon paper smudge from the boat deck. Use a draftsman's ruling pen and ruler, or a pair of triangles, to outline the

NAME ON STERN OF POWER BOAT

FIG-40.

FIG-39.

BRIGHT FINISH MAHOGANY.

BOOT TOPPING.

BOTTOM PAINT

(DECK)
BRIGHT FINISH BIRCH, NO STAIN.

MAHOGANY
HALF ROUND.

·MISS·NEW·YORK·

NAME ON STARBOARD SIDE
OF DECK FORWARD, PORT SIDE SIMILAR.
YELLOW OR GOLD LEAF LETTERS
OUTLINED IN BLACK.

letters on the deck, in order to have their outlines clean-cut and regular. Get a small quantity of gold leaf size from a paint store and use if for outlining and filling in the entire surface of the letters. Let it stand for about four hours and when the size is nearly set, that is, it will not stick to the fingers but has a tack and a snap left on its surface when the finger is pressed against it, apply the gold as later described. I should have stated after the letters were outlined in carbon paper and before the size was applied a little soapstone or face powder should be dusted over the dry varnished work in the vicinity of the name to prevent the gold leaf adhering where it is not wanted.

Gold leaf comes in small books, loose and patent. The patent gold is in some way pressed to the paper pages of the book so that it will not blow off when it is being used, the loose gold leaf is simply laid in between the pages of the book. A book of gold costs about fifty or sixty cents and will do the names of a dozen boats. Take out a paper page from the book, to which a thin sheet of the gold is pressed, and press the gold leaf side against the sized part of the name. The gold adheres readily and will remain permanently. Dust off the surplus gold hangings with a camel's hair brush and allow it to harden at least over night. Wipe off any powder that may remain on the varnish, and apply the remaining coats of varnish. Be careful not to rub through or you will spoil the gold name. Before applying the varnish over the gold leaf or the yellow painted name, it will look better if the letters are outlined with a thin black line. Use black japan paint in a ruling pen. The name on the transom is of course similarly applied except the name is on a straight line parallel to the water line.

CHAPTER IV

MASTS AND SPARS

In old time sailing ships, the rule for determining the ratio of the diameter of a spar for a given length was as follows:

Masts of ships one inch in diameter for every three feet of length.

Masts of schooners one inch in diameter for every four feet of length.

Booms and spars one inch in diameter for every five feet of length.

That is, in the case of a ship with a total height of mast of seventy-five feet, the stick at its greatest diameter would be twenty-five inches. And in a schooner, where the mast was forty feet high the diameter of the stick at its greatest point would be ten inches—and so on.

A mast has its greatest diameter at the partners, because it is supported at this point by the deck, and anything above this point is unsupported, or rather it is considered so. As a matter of fact, the standing rigging and shrouds help considerably. A mast is usually stepped, (fastened at its lowest point), down in the hold of the ship, and is supported at the partners. The greatest bending moment, (tendency to break), is at the deck. But in the case of a boom or gaff the greatest stress is at its mid-length, because

it is secured to the mast at one end and held by a sheet or stay at the other end, and the pressure of the wind on the sails acts like a series of weights suspended at right angles to the stick. Consequently, in such spars, the greatest diameter must be near the middle of the length. For the sake of looks let it be a little nearer the mast end.

The professional way to make a mast or spar is as follows: Your material should be spruce and it should be secured from a mill in a clean stick a little longer than you require, free from knots or splits, and square in cross section. Of course, it should be a little larger than the greatest diameter necessary. Then a center-line is snapped with a chalk line on each of the square faces, and the true shape of the final spar marked thereon—see Fig. 41. On a small model stick, the center-line would be put on with a ruler and pencil. After the shape of a spar is drawn, cut it out, and you will have the exact shape of the mast or spar, but it will be square in cross sections (four sided), Fig. 42. Next carefully cut or trim it with a small plane into an eight sided figure—Fig. 43; then gradually into a round, Fig. 44. Rub it down with sandpaper by turning the stick around in the hand in which a piece of sandpaper is held. Finally varnish it and polish.

Some boats are fitted with hollow spars. This feature allows one to have a stronger and lighter mast or spar for a given weight than if it were solid. The reason is that the hollow spar, which will measure a little larger in diameter than the solid spar and will weigh a little less, has what is called a greater "moment of inertia." Take for instance a solid steel rod

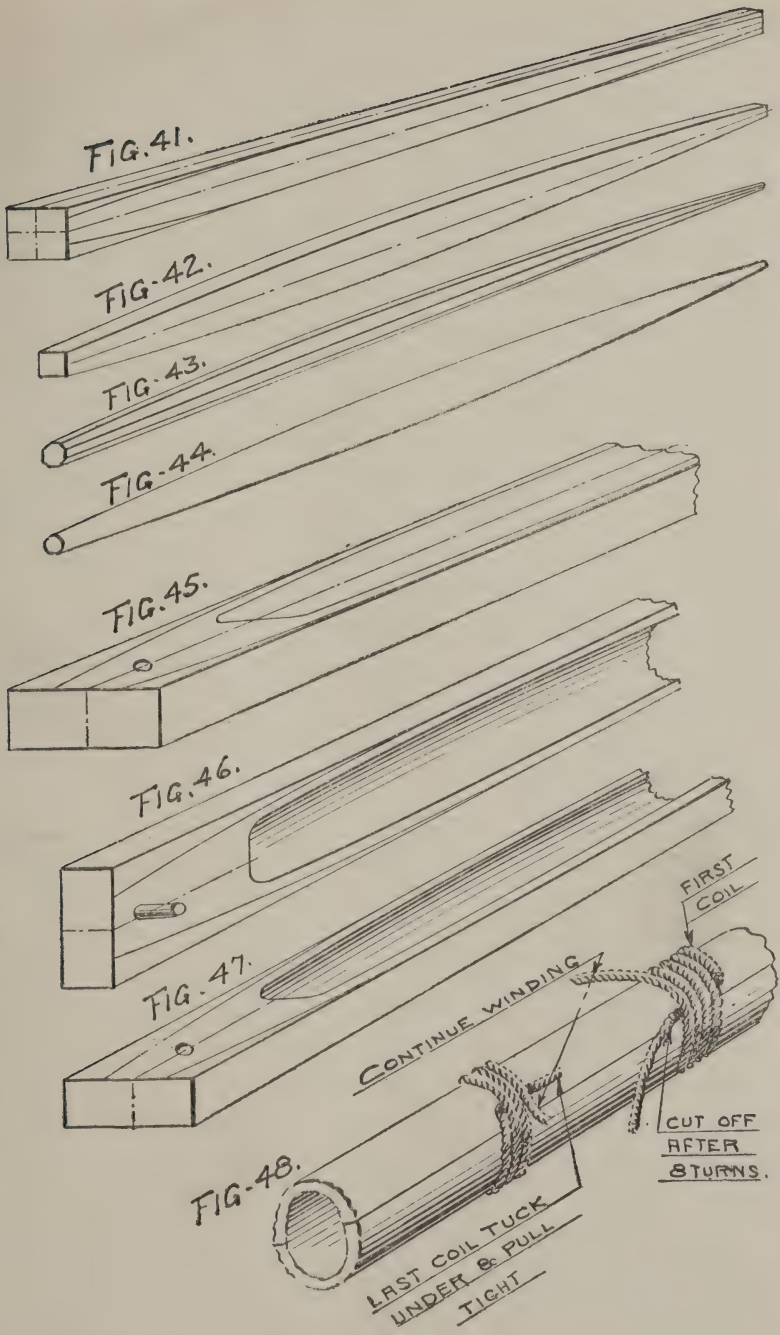


FIG. 41.
FIG. 42.
FIG. 43.
FIG. 44.
FIG. 45.
FIG. 46.
FIG. 47.
FIG. 48.
FIRST COIL
CONTINUE WINDING
CUT OFF AFTER 8 TURNS.
LAST COIL TUCK UNDER & PULL TIGHT

one-quarter of an inch in diameter. It will bend with less load on it than will a hollow tube say five-eighths of an inch in diameter with exactly the same quantity of metal in it per foot of length.

Likewise, if we wanted to produce a hollow steel tube of exactly the same strength as the one-quarter of an inch rod we could do so with considerably less material per foot of length than the quarter of an inch rod. Therefore, we would be saving considerable weight.

The rule of ratio of diameter to length of the hollow spars will be about 25 per cent. greater than the solid spars. This is how they are made. If your spar is to be, we will say, $1\frac{1}{2}$ in. in diameter by 3 ft. 0 in. long, you would require two pieces of clear spruce $1\frac{1}{2}$ in. x $\frac{3}{4}$ in. x 3 ft. 6 in. long, nicely dressed, particularly on the surfaces of the $1\frac{1}{2}$ in. face, because these faces will be glued and bradded or dowelled together. Mark the center line on all of the $1\frac{1}{2}$ in. faces and draw in the outline of your true shape of the stick, then about $\frac{1}{8}$ in. inside of these lines draw another set of parallel lines. See Fig. 45. This will be the thickness of the mast or spar when it is finally hollowed out. One inch from each end of the stick drill a $\frac{3}{16}$ in. dowel hole completely through both halves of what will be the complete mast; after you have made sure the two $1\frac{1}{2}$ in. x $\frac{3}{4}$ in. strips are placed truly one over the other, their $1\frac{1}{2}$ in. faces being in contact, hold them in "C" clamps while drilling for the dowels. Then glue the dowels in one of the halves. Now proceed to gouge out each of the two halves but do not go deeper in any place than a true circle, the diameter of which is the distance between the two inside boundary lines at the particular

point. The two halves will be like Figs. 46 and 47 when ready to glue. Apply waterproof glue and fit together, using plenty of clamps. Cut the two ends off that contain the dowels, after the glue is hard. Proceed to shape the mast as for solid sticks. If you have gone too deep in hollowing in some places you may be in trouble. After the spar is finished and varnished you may, if desired, size it at intervals, as indicated in Fig. 48, with pure linen or silk yarn. The sizing should be varnished after completion. The sizing in the cut is indicated as quite heavy material. This was done in order to indicate it clearly. The actual material to be used is in reality light strong yarn that would scarcely be noticed.

Spruce is a cheap wood but is the best to use for spars. It is soft and light and white. When finishing use varnish only. Details of bands and fittings will be given with the specific boat described. Always drill a pilot hole in a spar before fitting a fastening. Be sure to select a straight grained stick and keep it flat or standing upright until you use it so that it will not bend out of shape.

CHAPTER V

TOOLS AND WORK BENCH

A good work bench, as shown in Fig. 49, with a vise, and located where there is heat and a good light, will make the work considerably easier. If it can be located where all the work does not have to be cleared up and the tools put away each time one stops work, it will be much better, and will save time. This, of course, does not mean that the place should not be cleaned up, and the tools put away, for a good workman will always do this. A dry cellar or an attic is an excellent place.

Tool benches may be purchased but they are expensive. Mine was built at a cost of $3.50 for the materials. It was fastened together with bolts and nuts so that it could be taken apart and stored if necessary. The top was made from four pieces of yellow pine 2 in. thick by 6 in. wide and 5 ft. long. This makes the bench 5 feet long and 2 feet wide. The top boards were dressed and bolted to three cleats, one near each end and one in the middle. These cleats, as well as the legs, were of spruce 2 in. x 4 in. dressed. The legs were cross-braced and bolted together as shown in Fig. 50. The slots, Figs. 51 and 52, in the cleats, which support the top boards, were for the purpose of allowing for expansion or contraction of the top boards. A shelf at the bottom comes in handy for tools and odds and ends. Although no drawer is shown, one will come in handy and may be added

FIG-49.

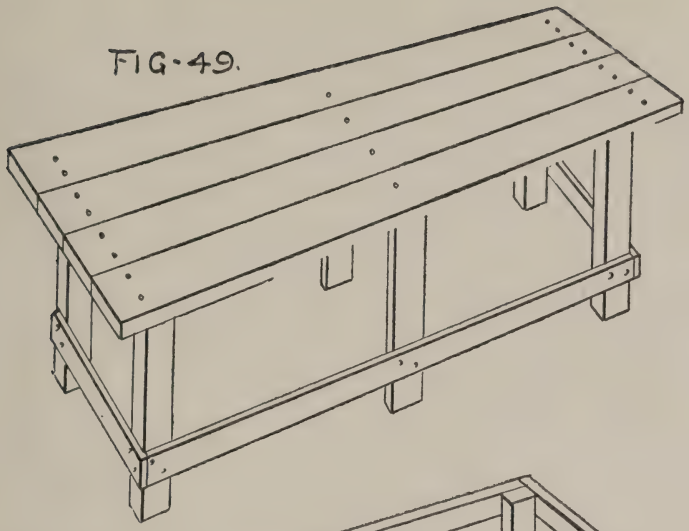


FIG-50.

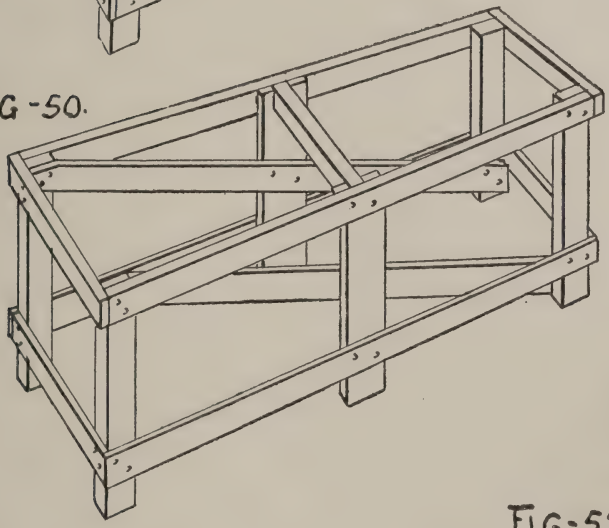


FIG.51.

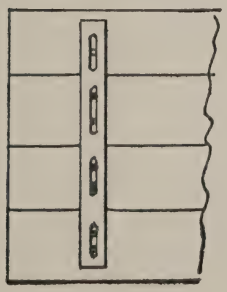
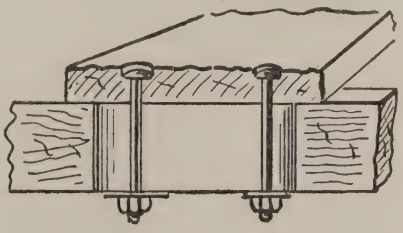


FIG-52.



easily. A shelf at the back of the bench, arranged about two feet higher than the bench itself, is good, because one soon gets into the habit of placing tools that are not in use on this shelf instead of littering up the top of the bench. For all around purposes a metal vise is the best.

The tools which should be on hand for miniature boat work depend upon whether the builder intends buying some of the parts partly shaped, or prefers making the boats complete. Tools will be listed first for fabricated boats and then an additional list will be given for those desiring to do all the work themselves.

One small, fine toothed, cross grained back saw.
One steel framed coping saw and six blades.
One small hammer.
One good wood chisel. 1 in.
One good gouge. 1 in.
One small screw driver.
One small adjustable block plane.
One four-foot rule.
Several sheets of "00" sandpaper.
Several sheets of "0" sandpaper.
Several sheets of "1" sandpaper.
One good pen knife.
About twelve small cast iron "C" clamps with a 2 in. jaw.

Those doing general model work and making all the parts should have, in addition to the above:

A rip and a cross cut saw.
A draw knife.
A smoothing plane.
Brace and bitts and at least six large gluing clamps.

In making the work bench you should endeavor to have the top perfectly level. In order to do this, cut all four legs to the exact length, and then let their top edges butt, wood to wood, to the under side of the top boards. Then, if the floor on which your table or bench will rest is level, it is easy, but if this is not the case, level it up with thin wedges and then tack the wedges to the bottom of the legs.

The bench, as designed, is fairly heavy, but that is what is required. A light, wabbly bench is worse than nothing and adds to the difficulty of the work.

The expenditure of four or five dollars for a work bench and the additional expense of buying good tools can hardly be called an extravagance in view of the fact that such a combination may be used extensively for many other purposes besides model building. In making the ordinary repairs about the house, the cost will be saved in short order.

Several firms make small tool sets and they are safe to buy if they are composed of standard, well-known makes. My tools were collected one at a time, this being the usual method. Some of them I purchased in second-hand shops, and one is perfectly safe in this respect, if one sticks to standard makes, avoiding tools on which the maker's name does not appear. One can use the finest tools made, in good materials, the kind specified for these boats, with no harm, but look out for nails in old material before attempting to finish them with a plane or a chisel. The three-ply veneer is, however, extremely tough, and will take the edge off tools very quickly. Keep all the tools clean and sharp, and since so little is

known of this art, what follows may be interesting and instructive.

The first operation, in sharpening tools, is grinding. There are two forms of grindstones, the old-fashioned water-wheel and the emery or carborundum wheel. The water-wheel is large and makes considerable dirt, it runs with the wheel partly in water. Water-wheels are best for large tools, and the smaller, high-speed carborundum wheels, for small tools. Due to their smaller diameter they cut a concave bevel in the face of the tool which makes frequent grinding unnecessary. The water on the water-wheel prevents the friction caused by the tool with the moving surface of the wheel from heating the tool and drawing its temper. No water or oil is used with the emery or carborundum wheel, consequently considerable care must be exercised in order not to hold the tool too hard or too long against the wheel. Care must be exercised with these wheels not to draw the temper of the tool.

Always grind with the surface of the wheel moving toward the tool. The handle to be held always at the same distance from the wheel and at the same angle in order to make a perfect concave bevel. If the tool is raised and lowered the bevel is apt to be convex instead of concave.

Tools that are to be used with soft wood may be ground with a longer bevel than those to be used with hard wood. The long bevel grind requires less effort in cutting in soft wood, but is frequently not "stiff" enough to stand up in hard woods. When using either type of grinding wheel be careful not to wear the grinding surface of the wheel unevenly.

After grinding, the tool should be finished on an oil

stone. Straight edged tools, such as chisels, should be held with the left hand in front of the right, (for a right-handed person). The right wrist should be straight, in line with the forearm. The left hand steadies and guides the tool and furnishes the downward pressure.

Always move the tool straight forward and back, not with a side, diagonal or circular movement; keeping it constantly at the same angle with the stone. This is done by moving the hands horizontally forward and back, but not raising or depressing them during the stroke. The pressure of the left hand should only be exerted during the forward part of the stroke.

When the edge is sharp, which can best be told by looking at it, there will be no flat ledge left to reflect the light. Then turn the tool over and lay it perfectly flat on the stone and with a few diagonal strokes remove the wire-edge or burr. Gouges should be sharpened the same as chisels, except that they must be constantly rolled to right and left during grinding and during each stroke on the oil stone. Small circular oil stones called slips are used for removing the wire-edge or burrs from gouges or other similar shaped tools.

Curved plane irons should first be ground to conform accurately to the curve of the sole of the plane and then worked on the oil stone as explained for gouges. Irons for planes with flat soles should be ground and sharpened with straight edges, except that the edge should be very slightly rounded off at each end to prevent marking the work with sharp furrows. Irons for a single-iron jack-plane should be

rounded, and for other jack-planes slightly rounded at the corners. In sharpening draw knives place one handle flat on the work bench, hold the other in the left hand with the edge to the right, then pass the oil stone backward and forward from one end to the other, holding it firmly and keeping the angle true.

Be sure to keep the oil stone clean and moist when not in use and when using apply enough oil or water to prevent the particles ground from the tool from becoming imbedded into the stone causing a glazing of the surface. This greatly impairs its effectiveness.

Do not attempt to sharpen a saw but take it to a good hardware store or a saw filer. Never use a rip saw to saw cross grain and never use a cross cut saw to rip. Saw teeth, besides being filed sharp, have a set put in them; that is they are bent over or out, the first tooth is bent, say to the right, and the next to the left, the next to the right, and so on, the cross width of the teeth being just a little more than the thickness of the saw material. This keeps the saw from sticking or jamming and being hard to push. Just as soon as a cross cut saw is used to rip (sawing with grain of wood) the teeth are forced in straight again and the saw loses its set. A rip saw used to cut cross grain, haggles the grain of the wood and breaks little particles out of the surface near the edge of the cut.

If you are not going to use your saws for sometime, or if they are kept in a damp place, have an oily rag handy or use a little thin automobile cup grease to wipe over the blade, particularly near the teeth, to prevent rusting and loss of the cutting edge. In general, about tools; cheap ones of the "five and ten" variety are of no use at all. One may, however, pick

up "C" clamps good enough for light work in the "five and ten" stores. I have told of the tools that should be on hand in model making in order to do the best and easiest job, but as a matter of fact, I have seen good models, particularly where fabricated parts are secured, made with a tack hammer, small screw driver, a good, heavy-bladed penknife and about six sheets of sandpaper, the latter ranging from quite coarse, for roughing, to double "0". The only work bench was an old discarded table.

If one can afford it, it is better to purchase the best tools one can obtain because such tools last a lifetime and there is a certain pleasure in having the proper tool for each operation. The work is done more neatly and expeditiously with the tool designed for the work than with extemporized appliances. A well-equipped and neat workshop is a joy and pride to the owner and the envy of his less fortunate friends.

CHAPTER VI

DEFINITIONS AND NAUTICAL TERMS

Aback. When the pressure of the wind on the sails of a ship has a tendency to drive it astern.

Aboard. On or in a ship.

About. When a sailing ship is beating to windward it changes its course, allowing the wind to bear on the opposite side of the sails. To change from the starboard to the port tack or the reverse.

Abaft. Toward the stern, aft, relative to.

Abeam. At right-angles to the vessel's longitudinal axis and in her plane of flotation.

Abreast. Over against, opposite.

Adrift. Afloat without effective means of propulsion or control.

Aft. In the direction of or toward the stern.

Ahead. Forward, in front of.

Alee. Away from the wind. To carry alee helm.

Aloft. In the tops or upper rigging, above the decks.

Amidships. In the vicinity of the middle portion of the ship distinguished from her ends.

Astern. Signifying position in the rear or abaft the stern, as regards motion, the opposite of going ahead, backwards.

Athwartship. In a transverse direction, from side to side at right angles to the fore and aft center line.

Awash. Level with the surface of the water.

Backstay. Stays which extend from all mast levels, except the lower, to the ship's sides, some distance abaft the mast, for the purpose of preventing the masts from going forward.

Bark. A vessel having three masts, fore, main and mizzen. The two forward are square rigged and the mizzen is fore and aft rigged.

Barkentine. A vessel having three masts, the fore mast is square rigged and the main and mizzen are fore and aft rigged.

Beam. The extreme width of a ship. A transverse number supporting a deck.

Beam Moulded. The extreme width of a ship taken to the outside of the frames but inside of the planking or plating.

Bear-up. To alter course, turning the ship's head more away from the wind. Literally to bear the helm to windward.

Batten (Spline). A thin strip of smoothly finished wood, usually about a $\frac{1}{4}$ in. or $\frac{3}{16}$ in. square, tapered toward each end and from three to six feet long. Used in connection with shipweights or pins to draw in the curved lines of a ship, such as, sheer, frame lines or half-breadths.

Beating to Windward. Proceeding as nearly as possible in a direction toward the wind, by means of tacking.

Before the Wind. Having the wind directly aft.

Becalmed. Without wind.

Belay. To make a rope fast.

Bending Sails. Securing the sails to the mast or spars.

Boot-Topping. A narrow strip of painted surface

of a vessel "between wind and water." A longitudinal striping of paint, usually a different color than the underwater or above water color. Should be run in just above the water line for a finish. On a large ship usually from 6 in. to 18 in. wide, generally wider forward than aft.

Bilge. The round or sharp portion of a vessel where the bottom connects to the sides. There are round bilges and square bilges.

Bight. A loop in a rope.

Brig. A two-masted vessel, square rigged on both.

Bow. The forward end of a ship, the opposite to the stern.

Brigantine. A two-masted vessel square rigged on the foremast.

By the Head. A vessel is said to be trimmed by the head when she is down deeper in the water forward than aft.

By the Stern. The opposite of "by the head."

By the Wind. Sailing as close to the wind as possible. Close hauled.

Close Hauled. Sailing as close to the wind as possible.

Center of Effort. The center of pull of the combined sail area. Center of gravity of combined sail area.

Center of Lateral Resistance. The center of resistance of the water on the fore and aft plane of the immersed body of a vessel. The center of gravity of the fore and aft plane of the immersed body of a vessel.

Chine. A timber in a "hard bilged" boat that runs fore and aft and connects the bottom to the sides.

Cleat. A two-pronged fitting fastened to a ship for securing a rope.

Chock. A fitting secured to a boat for leading a rope inboard to a cleat without chafing the rope.

Coaming. In small boats the finishing boards that form the cockpit and extend above the deck. They keep the water and spray out of an open boat.

Clamp. A timber in a boat that runs fore and aft and connects the sides to the deck.

C Clamp. A metal clamp used to assist in gluing. Made in the shape of a letter C, having a screw threaded member mounted in the top which may be turned down to grip material of different thicknesses.

Crank. A vessel is said to be crank if she lists over easily. The opposite of stiff.

Crown. The upward curve of a deck as viewed transversely. Decks are usually not flat, but have a crown in order that they may shed water.

Counter. The part of a ship's after body extending aft from the after perpendicular, usually above the water line.

Dead Flat. The portion of a vessel where the greatest beam is attained. Maintained for varying distances.

Draft. The depth a vessel sinks in the water when floating.

Drag. A vessel is said to have a drag when her keel is deeper in the water at the stern than forward.

Draw. A sail draws when it is filled with wind. To let draw is to ease off the weather sheet of a head sail and to haul in the lee sheet.

Ensign Staff. The flag staff at the stern of a vessel on which the national or yacht ensign is flown.

Jack Staff. The flag staff at the bow of a vessel on which the union jack, (the field of the national emblem), is flown. In a small power boat the club burgee is correct on this staff.

Faying Surface. Two surfaces in immediate contact. The faying surfaces of a boat must fit perfectly to exclude the water.

Flam. A term often used to express the same meaning as flare but more properly to denote the extreme upper part of the flare out of the side of the ship forward, just under the line of the weather deck.

Flat Aft. The sheets of a fore and aft sail are flat aft when they are hauled in as far as possible for sailing close hauled.

Flush Deck. Is a level or even deck throughout its extent. A flush deck ship is a ship with a flush upper deck having no raised deck at either end.

Freeboard. The portion of a vessel which extends above the water when floating.

Full and By. Sailing close hauled, to keep the sails full.

Gather Away. When a vessel begins to move through the water.

Go About. To tack.

Going Free. Sailing with the wind on the beam or quarter.

Gybing Sail. When running nearly before the wind and the wind gets on the lee side of a fore

and aft sail, blowing it over to the other side, it is said to "gybe."

Halving. When two timbers are joined, they are halved together, when a notch half the depth of each is cut out, (when the timbers are the same size) or if not the same size, half the depth of the smaller one. The keel is halved into the transom.

Halyard. Line for hoisting signals, flags, sails, etc.

Heading. The direction of the ship's head.

Hermaphrodite. A brigantine.

Hogged. The bow and stern of a vessel having settled below their original level.

Hull Down. When only the spars of a vessel are visible above the horizon.

Hove To. Keeping the ship stationary by making one sail work against the other.

Inboard. In toward the fore and aft center line. Inside the hull of the ship.

Outboard. Out toward the side of the ship and away from the fore and aft center line, or outside of the ship.

In Irons. A vessel is said to be in irons when she is head to wind and will fall off on either tack.

Intercostal. Being disposed between, not continuous.

Keel. The lowest central fore and aft member, usually running the full length of a vessel, connecting the stern and the stem post.

Leech. The side edges of a square sail or the fore and aft edge of a fore and aft sail.

Lee Side. The side away from the wind.

Lée Helm. The helm put down to leeward to bring the vessel up to the wind.

Lugger. A vessel having from one to three masts rigged with quadrilateral fore and aft sails bent to yards.

List. Leaning to one side, over balanced.

Luff. To turn the head of the vessel toward the wind. To sail nearer the wind.

Mainsail. The principal sail carried by the mainmast.

Marline Spike. A pointed tool usually of steel used for opening the strands of a rope, in order that another strand may be tucked in when knotting or splicing.

Mast—A long pole of steel or wood, usually circular in section, which is erected vertically on the center line of the ship.

Mast, Fore. The first mast from the bow.

Mast, Main. Second mast from the bow.

Mast, Mizzen. Third mast from the bow.

Mold (Shape). A thin wooden or stiff paper pattern made for checking the curve of a ship's side.

Overboard. Over the side. Into the water.

Pilot Hole. A hole drilled into a piece of material smaller than the fastening to be used in order to prevent the fastening from splitting the material when it is driven in.

Port. The left hand side of a ship looking from aft to forward (at night marked by a red light).

Rabbet. A groove in the stern, stem or keel of a boat into which the planking or plating is fitted.

Run. The under-water portion of a vessel aft of the greatest beam.

Rudder. A device used in steering or maneuvering a vessel, usually a flat slab of steel or wood hung at the stern of the vessel, the same being adapted to be turned to the right or left as desired.

Ruling Pen. A flat, sharp, adjustable, two-jawed instrument used by draftsmen for drawing a fair ink-line with the aid of a ruler or spline.

Sloop. A single masted boat with jib and mainsail.

Spar. A timber or stick upon which the sails of a boat are bent.

Starboard. The right hand side of a ship looking from aft toward forward (at night marked by a green light).

Stability. The tendency which a vessel has to return to upright when inclined away from that position.

Schooner. A fore and aft rigged vessel with two or more masts.

Sheer. The profile of a boat. The curve of a deck as viewed longitudinally. A boat may have a curved sheer or a straight sheer.

Sheet. A line for controlling the angle of a sail.

Scud. To run before a gale of wind with little or no canvas.

Standing Rigging. The fixed rigging such as stays or rattlings.

Steerage-Way. Going ahead or astern with enough speed to enable the rudder to control the movements of the vessel.

Striping Brush. A long, thin, flat brush used by painters for cutting in a straight even line.

Stern Tube. A metal tube passing from the inside

of a vessel, near the after end, through the bottom into the water, through which the propeller shaft passes.

Tack. To go about, to change from one tack to another.

Transom. The flat after end of a boat.

Top Side. Above the water, upper deck.

Strut. A metal arm extending outboard from a vessel for supporting the propeller shaft, usually located aft.

Stuffing Box. A metal fitting, screw threaded at the end of the shaft tube, through which the propeller shaft passes from the sea into the inside of the boat.

Tiller. The handle for operating the rudder.

Tumble Home. A vessel's sides are said to have a tumble home when she is wider at the water line than at the top side deck.

Wetted Surface. The portion of a ship's hull in contact with the water.

Waist. The middle portion of a ship's upper deck.

Wake. In wake of, behind. The water left astern of a vessel under way.

Universal Coupling. A flexible coupling disposed between the drive shaft of an engine and the driven shaft, so that the former shaft may be at a slightly different angle than the latter and at the same time cause no binding in the bearings.

Yaw. To work from side to side in going ahead.

CHAPTER VII

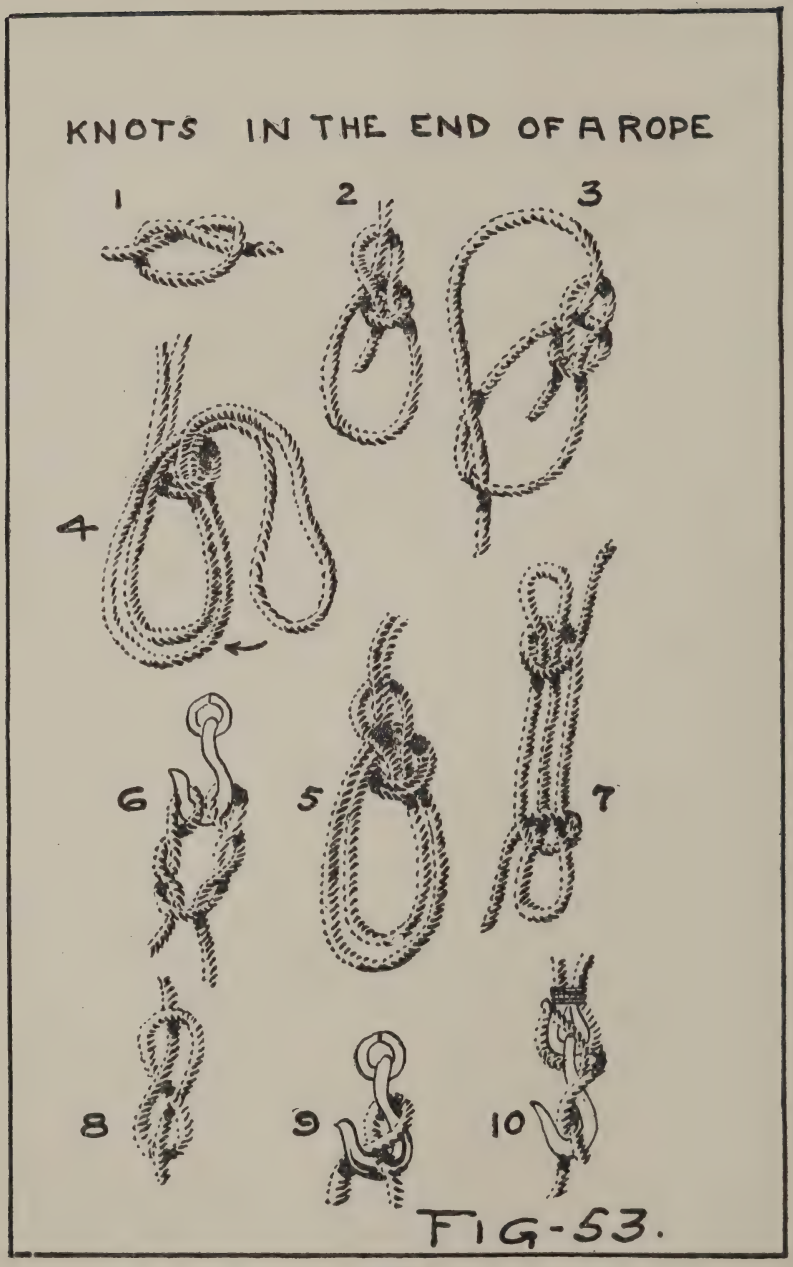
KNOTS AND SPLICES IN ROPES

In order that the reader may acquire a seagoing knowledge and place himself in the atmosphere of things pertaining to this important branch of a deep sea sailor's ability, the writer feels it necessary to explain the knots and splices most commonly used, although there may be no special requirement for them in use with the construction of the boats mentioned herein. A real sailor has as much contempt for one associating himself with boats who does not know the principal knots and splices as a land-lubber has for a bookkeeper who cannot keep books.

The old salts of yesterday look with some contempt on the sailors of today. There is a saying among the old-timers that in former years "ships were made of wood and the crew of steel while today the ships are made of steel and the crew is made of wood."

The art in working in rope cannot be learned entirely from books, but the illustrations will give the reader a good working indea of the most common knots and splices. Like all other things, practice makes perfect.

A small piece of rope about one-half inch in diameter will enable the beginner to experiment and learn to tie these knots with a little practice. Manila or hemp rope is never spoken of in terms of diameter, but always in circumference. For instance, the rope


KNOTS IN THE END OF A ROPE
1
2
3
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8
9
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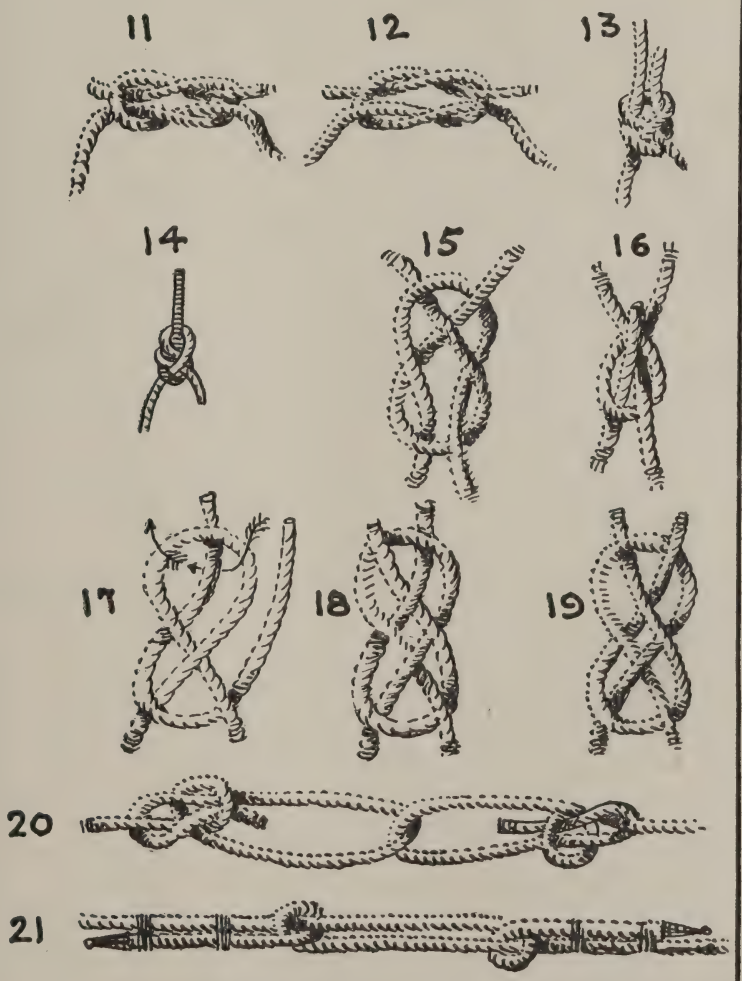
FIG-53.

BENDING TWO ROPES TOGETHER-

FIG-54.



mentioned, one-half inch diameter, would be called 1½ inch rope, because the circumference of a circle is about three times greater than its diameter.

KNOTS AND SPLICES

The following are a number of simple knots, all of which can be made with a single rope. (Fig. 53).

1—**Overhand Knot.**

2—**Bowline.** One of the most common and useful knots known in seamanship. It forms a loop, which may be of any length, and which cannot slip. The heavier the pull is the harder it jams. Moreover it does not form a nip sharp enough to weaken the rope. It is used for lowering men over a ship's side, for slinging them from stays, etc. A common use is to form a loop in the end of a hawser to throw over a bollard in securing the ship at a dock.

3—**Running Bowline.** A convenient form of running loop. The loop of the bowline proper is usually smaller than that shown in the figure.

4, 5—**A Bowline on a Bight.** Used in place of a single bowline where greater strength is needed or an increased number of parts.

6, 9, 10—**A Cat's Paw and a Blackwall Hitch.** Used for hooking a tackle to the end of a rope.

7—**Sheep Shank.** A quick and convenient way of temporarily shortening a rope.

8—**Figure of Eight Knot.** Turned in a rope to prevent its unreeving. It will not jam as an overhand knot will do.

The following are a number of common knots for connecting two ropes. (Fig. 54).

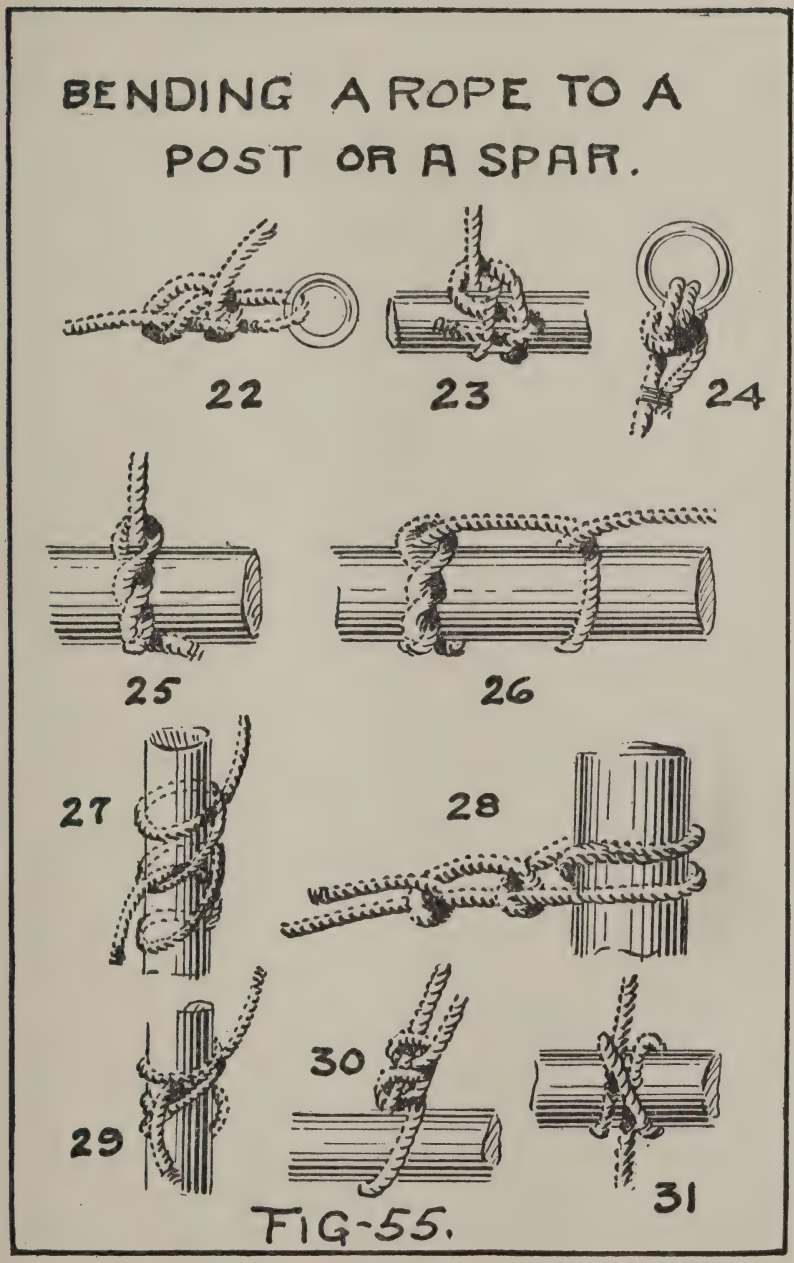


FIG-55.

11—**Square or Reef Knot.** This is the simplest and one of the most useful. It should be distinguished from the granny knot, Fig. 12, which does not hold as well and is hard to untie. A square knot will not answer for uniting ropes of different size, as the parts would slip unless stopped down.

13—**Sheet or Becket Bend.** Called by landsmen a "weaver's knot." May be used where the parts are of different size.

14—**Sheet Bend Double.**

15, 16—**Single Carrick Bend.**

17, 18, 19—**Double Carrick Bend.** Commonly used for bending hawsers together. If the two parts are of different size it is well to seize each part back on itself.

20, 21—**Two Bowlines and a Reeving Line Bend.** Are also used for bending hawsers together. The reeving line bend is particularly useful where the lines are to be veered out through a small pipe.

The following are methods for securing lines to spars, posts, rings, etc. (Fig. 55).

22—**Studding-sail Tack Bend.** Will not come adrift by the flapping of the sail.

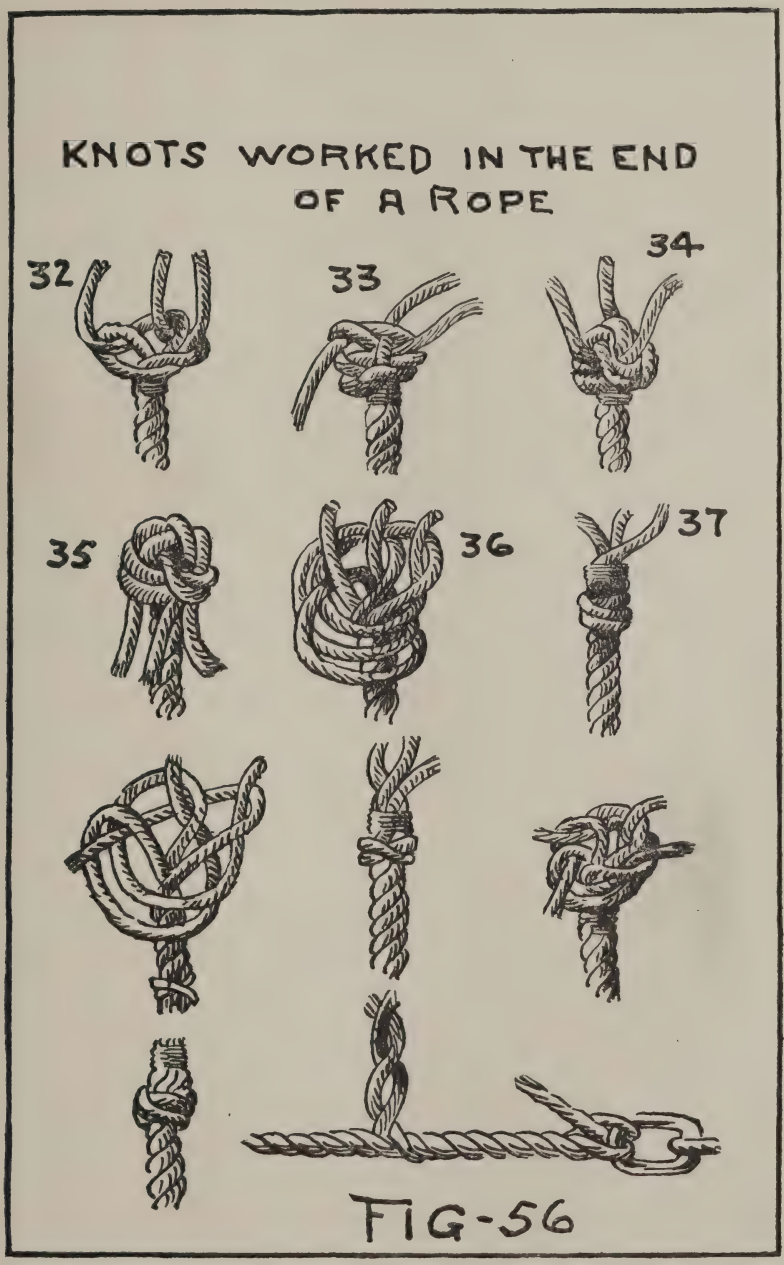
23—**Studding-sail Halliard Bend.** Lies flat to the yard.

24—**Fisherman's Bend.**

25—**Timber Hitch.**

26—**Timber and Half Hitch.** For towing or dragging a spar.

27, 29—**Rolling Hitch.** Very useful where one rope is to be bent to the standing part of another rope, or to a spar.


KNOTS WORKED IN THE END OF A ROPE
32
33
34
35
36
37
FIG-56

28—**Round Turn and Two Half Hitches.** For making a hawser fast to a bollard. For greater security the end should be stopped down to the main part.

30, 31—**Two Half Hitches and a Clove Hitch.**

The following are a series of knots which are worked in the end or the body of a rope, using its own strands. Knots of this kind are used to give a finish to the end of a rope or to prevent its unreeving. (Fig. 56).

32—**Wall Knot.**

33—**Wall and Crown.**

34—**Double Wall and Single Crown.**

35—**Double Wall and a Double Crown or Man-Rope Knot.** Used on the end of a man-rope trailed over the side to give a good hold for man overboard.

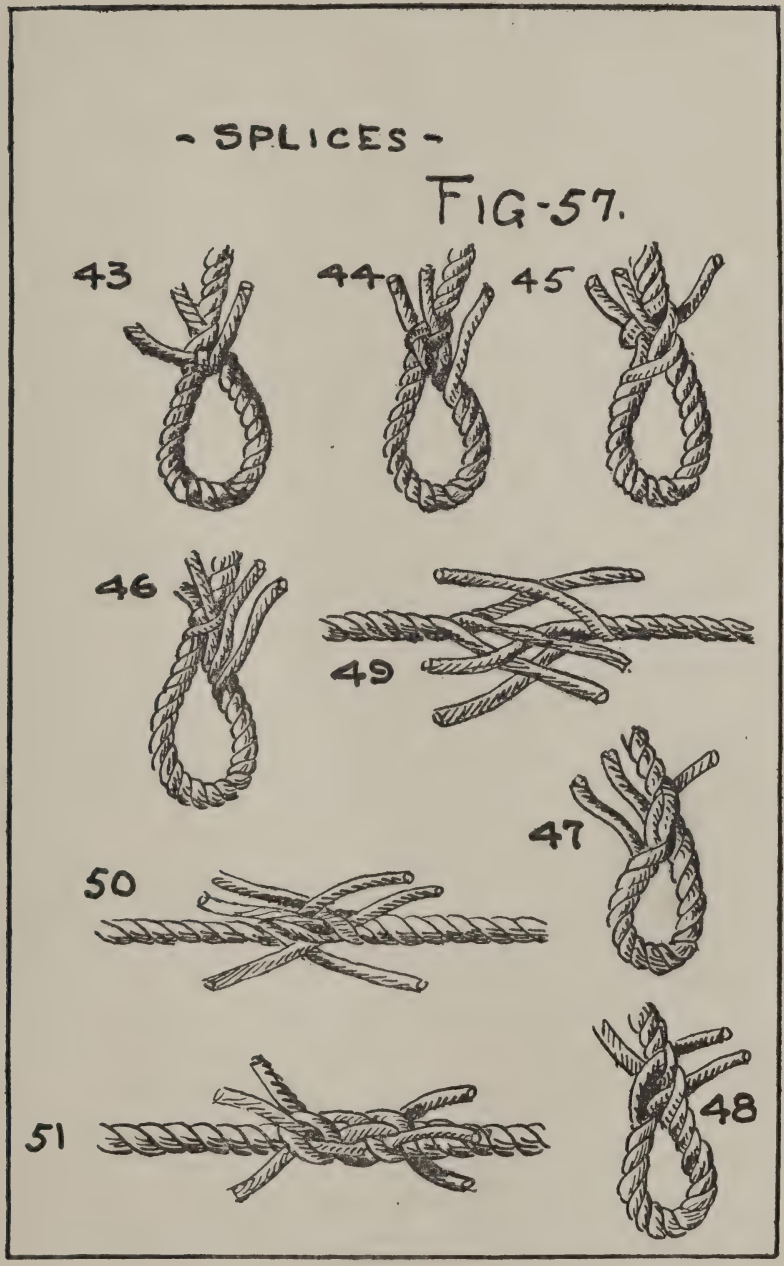
36, 37, 38, 39—**Matthew Walker Knot.** Double and single.

40, 41—**Lanyard Knot.** Used on the end of a lanyard to prevent unreeving through the dead eye.

SPLICES. (Fig. 57)

42—**Chain Splice.** For splicing a rope to a chain.

The following show various forms of splices for joining the ends of two ropes permanently or for bending the end of a rope back upon itself to form a permanent eye. The strands of the rope are tucked in. The lay of the rope where they go through is opened out by means of a marline-spike. The strands are tucked through once their original size, then reduced in size by cutting away a number of threads and tucked a second time. Reduce once more in


- SPLICES -
FIG-57.
43
44
45
46
49
47
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51
48

size and tuck again. It is thus tucked once full size, once two-thirds and once one-third. This gives a neater splice than if tucked three times full size.

43, 44, 45—**Eye Splice.** In three-strand rope. The rope is unlaid for perhaps a foot from the end and the strands brought back upon the body of the rope at a point which will form an eye of the size that is desired. Beginning with any one strand, this is tucked from left to right, through the strands of the rope (which are opened out with a spike) being passed over one and under the next. The other two strands are similarly tucked, always from right to left. All three are then trimmed down to two-thirds their original size, tucked again, trimmed to one-third their size and tucked a third and last time.

46—**Eye Splice.** In four-stranded rope. Here the first strand is tucked under two, but this for the first tuck only.

47, 48—**Sailmaker's Eye Splice.** Used on the roping of sails because it contains the original lay of the rope around the eye and is thus more convenient for sewing a canvas.

49, 50, 51—**Short Splice.** Two ropes are unlaid for a short distance and married together with strands interlacing. The strands of each rope are then tucked through the lay of the other rope exactly in the same manner as described for eye splices.

CHAPTER VIII

WHICH BOAT SHALL I BUILD?

Which boat shall I build? The natural inclination is toward the largest and fastest but that is not always possible to most of us. Experience and cost are important factors which must be considered.

The cost of building the hulls of any of the power boats except the forty-inch boat, planked and framed type, is small and practically the same.

The construction of the hulls for the twenty-four-, thirty-, thirty-six- and forty-eight-inch semi-block type is extremely simple. This type was developed to enable the most unskilled worker to produce a boat, in appearance, equal to the finest large racing yachts. The thirty-six-inch framed-up type is more difficult as it is constructed in exactly the same manner as the full-size race boats. Both the semi-block type and the framed-up type have exactly the same lines and shape. The framed-up type is a little lighter in weight, and due to the fact that it is constructed entirely of three-ply birch veneer glued with waterproof glue and secured to regular boat frames it is a trifle more rigid.

The complete boat, (twenty-four-inch semi-block hull), and spring motor is manifestly cheaper than the boats having high-powered steam outfits. The spring-driven motor is considerably cheaper in cost.

The difference between the semi-block type boat

and the framed-up type is as follows. The former has a bottom made of a block of wood, planed to shape and hollowed out so as to leave a wall one-quarter of an inch thick. The sides are of thin wood or veneer, and it has no frames or keel. Its shape is obtained by temporary moulds which are removed after the sides, the clamp timbers and deck beams are fitted.

The framed-up type is a little lighter and more professional because it is built over a skeleton frame exactly like a large boat of this type. This consists of the keel, stem, transom, chines, clamps and frames. The light but very strong $\frac{3}{16}$ in. thick waterproof veneer sides, bottom and deck being secured to this skeleton frame.

If you have had absolutely no boat building experience and you have a pond or lake large enough to sail a thirty- or thirty-six-inch boat, I would recommend building one of the semi-block types first. If this is not possible I would build a twenty-four-inch boat. Due to the fact that the thirty- or thirty-six-inch models are a little larger and are of the same construction as the twenty-four-inch boat, I consider them a little easier to build. If the cost of the steam power plant is too great, build the larger hull up to the point of installing the power plant. That is, fit the strut, shaft-tube, propeller, rudder and other parts, making a first class job of it. Paint and finish up and then install one of the spring-driven motors temporarily. These will drive the larger boats, but of course not with great speed. Later on, you can install one of the steam power plants and use the spring motor in a twenty-four-inch boat as a tender.

After building one of the semi-block types of

models, the amateur builder will probably have little difficulty in constructing the framed-up type. Furthermore, the power plant may be easily removed from one boat and placed in another, thus permitting some interesting comparisons.

The forty-inch power boat, planked and framed type, is a real job for the more advanced builder. A poor job may, however, be more easily disguised and patched up in this type of construction and the hull will stand a considerable amount of abuse and neglect when finished. If the seams are not tight when finished, they may be made tight with a little cotton and putty and if a good paint job is made they look like a regular job after all. Poor seams may also be stopped by shellac and wood dust. One cannot do any patching of poor connections on the other boats and all joints must be perfect. With the construction methods developed though this is an easy matter.

After all, the construction of the hulls of any of the power boats has been developed to such a degree that most anyone need have no fear to undertake building them.

CHAPTER IX

A FORTY-EIGHT-INCH RACING HYDROPLANE
(Semi-Blocked Type)

This is the largest, fastest and most powerful of the power boats described here. When fitted with the power plant designed for it (CF-2 boiler and 5-64 engine), it will develop a speed of twelve miles an hour. This power plant with the large tubular boiler and the four-cylinder high speed racing engine may be too expensive, in which case a smaller boiler and a two-cylinder engine or the spring type motor may be installed instead. Of course, only the first mentioned of the power plants will develop the speed of twelve miles an hour.

The hulls are of the semi-block type and are very simple with light rigid construction that will present no difficulty to anyone if the picture instructions are carefully followed.

The boat when completed has all the class and grace of the best and most expensively built big speed boats.

The chapter on power plants treats fully of the machinery installation. These power plants are fitted with all the safety devices which make them perfectly safe for anyone of ordinary, average intelligence to operate.

Arrangements have been made with firms specializing in these materials to carry in stock semi-finished

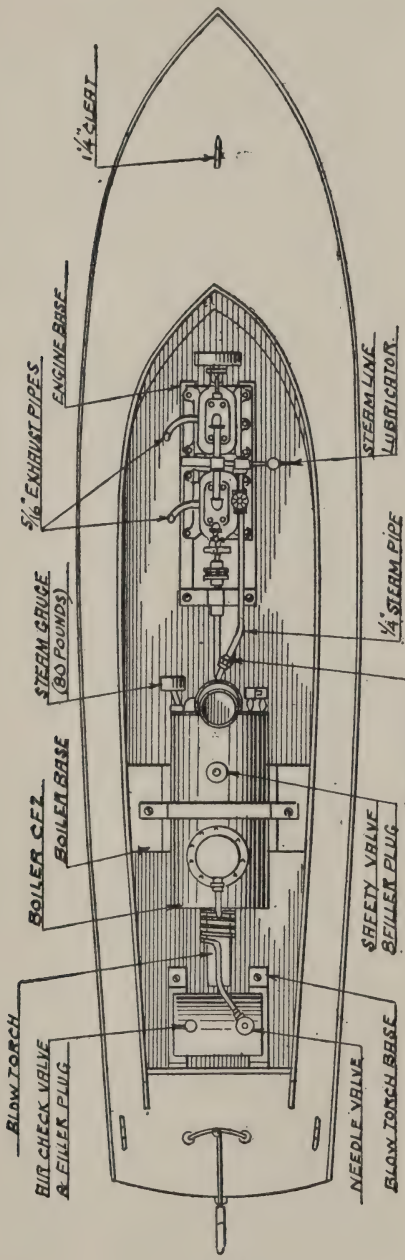

1/4" CLEAT
5/16 EXHAUST PIPES
ENGINE BASE
STEAM LINE LUBRICATOR
STEAM GAUGE (80 POUNDS)
1/4 STEAM PIPE
BOILER C.E.Z.
BOILER BASE
1/4" PIPE UNION
SAFETY VALVE
BOILER PLUG
BLOW TORCH
AIR CHECK VALVE
& FILLER PLUG
NEEDLE VALVE
BLOW TORCH BASE

FIG. 58.

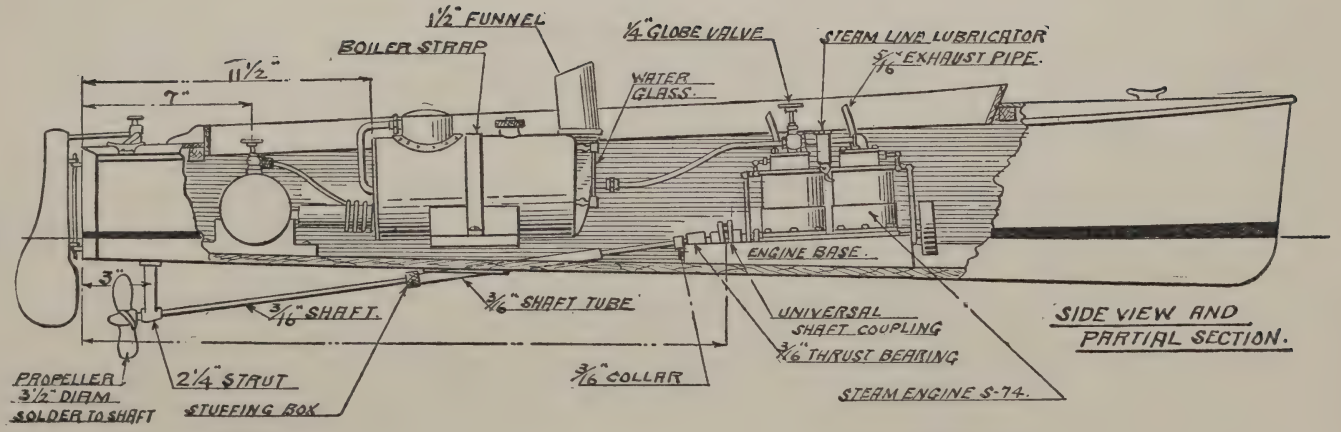

1½" FUNNEL
BOILER STRAP
¼" GLOBE VALVE
STEAM LINE LUBRICATOR
5/16" EXHAUST PIPE.
WATER GLASS.
11½"
7"
3"
3/16" SHAFT.
3/16" SHAFT TUBE
ENGINE BASE.
UNIVERSAL SHAFT COUPLING
3/16" THRUST BEARING
SIDE VIEW AND PARTIAL SECTION.
PROPELLER 3½" DIAM. SOLDER TO SHAFT
2¼" STRUT
STUFFING BOX
3/16" COLLAR
STEAM ENGINE S-74.

FIG-59.

parts for those desiring to build these boats. One may start from the rough material selected in the open market. Drawings and descriptions are arranged so that either course may be followed.

The power plants may be purchased in rough casting, machined castings, (ready to assemble), or the completely assembled units ready to hook up and run.

Figs. 58 and 59 show respectively a plan view of the completed boat and a profile with the sides partly broken away, showing the complete installation of fittings and machinery.

The partly finished material referred to is accurately cut by machinery and the specifications covering the wood to be furnished are very strict, specifying, in every case, the best grade of pattern-makers' kiln-dried material. The wooden parts come partly finished as follows:—

Piece 1—Bottom Block. Shaped in plan view and elevation as indicated in the cut. Operation No. 1. (Fig. 60.)

Piece 2—Stem Piece. Cut to proper length and end bevel; bored with a $\frac{1}{4}$ in. dowel hole.

Piece 3—Dowel. Turned to proper dimension and sufficient material to cut from.

Piece 4—Stern Piece or Transom. Material to cut from.

Pieces 5 and 6—Sides. Steam bent to shape and partly fabricated.

Pieces 5-A and 6-A—Clamps. Steam bent to shape and partly fabricated.

Pieces 5-B and 6-B—Carlings. Material to cut from.

Pieces 6-C—Deck Beams: Material to cut from.

Piece 7—Deck. Partly cut to shape.

Piece 8—Coamings. Steam bent to shape ready to finish.

Piece 9—Rudder. Partly shaped.

Piece 10—Motor-base Block. Material to cut from.

Piece 11—Burner-base Block. Material to cut from.

Piece 25—Boiler-base Block. Material to cut from.

Parts 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 26 and 27 may be purchased complete if desired, or in any state of completion as specified.

Those desiring to make the wooden parts from rough material will find full dimensions on the drawings to enable them to do so.

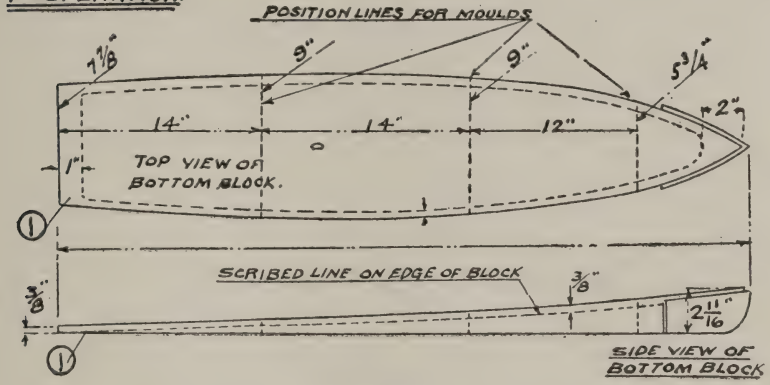
The general construction will not be explained, it being understood that all of the general chapters have been carefully read. Much information absolutely necessary is contained in these chapters.

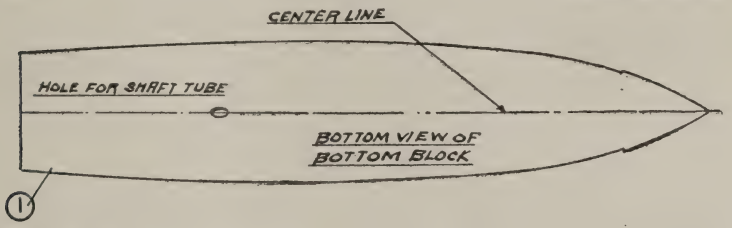
Operation One—Fig. 60: Lay out the bottom block, piece No. 1. Mark the position lines for moulds, following the dimensions as given. Mark the fore and aft center line on both the top and the bottom of block. Position lines for the moulds must be at right angles to the fore and aft center line. Scribe a line $\frac{3}{8}$ in. down from the top edge of the block on both sides, as shown.

Operation Two—Fig. 61: Bevel the underside of the bottom block, piece No. 1, from the center line to the scribed lines on the sides of the block, as indicated, using a straightedge as a guide in any cross section (see cut). Do the cutting with a small plane. Be careful not to cut away either center line or scribed

FIG-60.

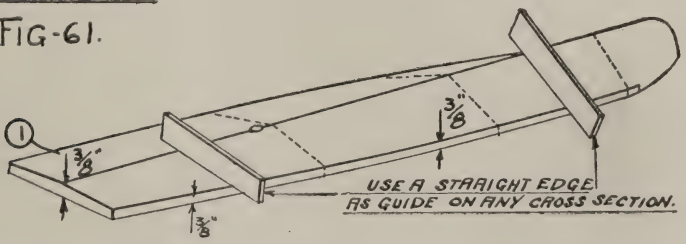
1ST OPERATION.





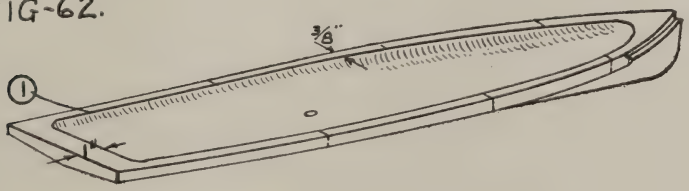
2ND OPERATION

FIG-61.



3RD OPERATION.

FIG-62.



lines, but just neatly to them, leaving the line showing.

Operation Three—Fig. 62: Carve out "cut out" for motor on top of bottom block piece No. 1 to line previously marked and leave a $\frac{1}{4}$ in. wall thickness all around. This may be done with a gouge. Be careful not to go thinner than a $\frac{1}{4}$ in. wall.

Operation Four—Fig. 63: Set the stem piece No. 2 in place and continue the $\frac{1}{4}$ in. hole into the bottom block, piece No. 1, but not all the way through. Secure the stem piece, No. 2, in place with the dowel, piece 3, and glue. Then drive in one small brad to hold it until the glue sets. Use waterproof glue only.

Operation Five—Fig. 64: Make the stern piece No. 4, (transom), $\frac{3}{16}$ in. thick, mahogany, to the dimensions specified under this operation. Make also the other three temporary moulds, using any convenient material for the latter, making them about $\frac{1}{2}$ in. thick. Be careful to lay these pieces out accurately to the dimensions as given. First lay out a vertical center line on each mould, then draw a fine, sharp line exactly at right angles to it. The latter line in each case will be the top of the mould. Then measure down the depth shown for the bottom line. Have the top and bottom lines of the moulds parallel to each other and exactly at right angles to the vertical center line. Then lay off the half-breadth of each at the top and bottom and connect the points carefully with a fine sharp line. Then saw the shape out and plane or sandpaper it exactly to the line. Be extremely accurate in laying out these moulds because the proper shape of the boat depends upon them. The notches

4TH OPERATION.

FIG-63.

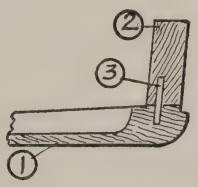
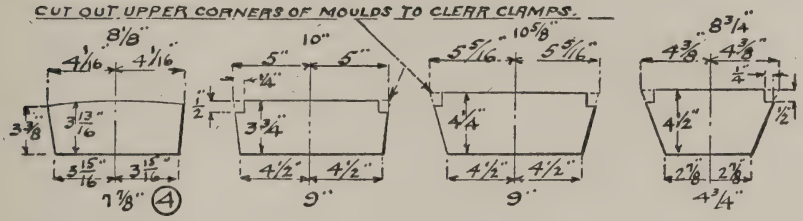


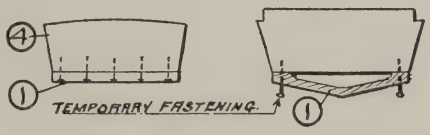
FIG-64

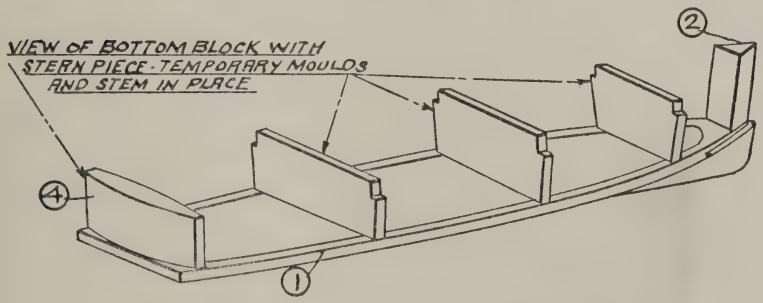
5TH OPERATION.



6TH OPERATION

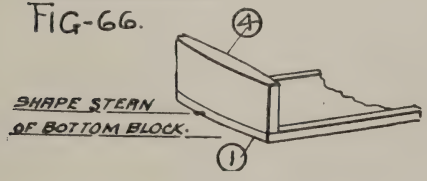
FIG-65

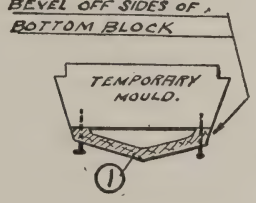




7TH OPERATION.

FIG-66.





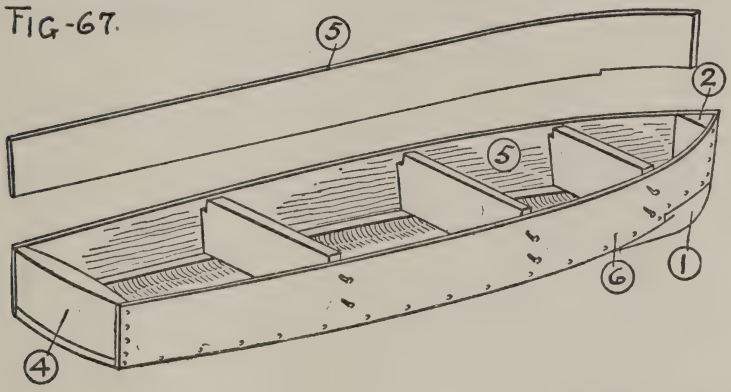
at the upper outboard edges of the temporary moulds are for the clamps.

Operations Six and Seven—Figs. 65 and 66: Fit the stern piece, (transom), and the temporary moulds in their proper places, each vertical center line of the moulds exactly matching up with the fore and aft center line of the bottom block and exactly over the transverse station lines of the block. If they fit, glue them permanently and brad the transom piece in place with waterproof glue as shown in operations 6 and 7. The other two moulds are only temporary so just drive two brads part way in each as shown. These brads will afterwards be pulled out and the hole plugged with a match stick cut to size and glued in place when the sides are fitted and the moulds removed. Bevel off the edges of the bottom block, as shown, in line with the sides of the stern piece and temporary moulds and curve of the back of the stern piece.

Operation Eight—Fig. 67: Carefully fit the side pieces 5 and 6 to the bottom block and into the jog at the bow, the stern pieces, along the edge of the botom block and at stem. Press the sides firmly into place and make sure that they come perfectly flat and fair and that the faying surfaces are perfect, otherwise the boat will leak. Trim carefully. Leave the side planks a little longer at each end and a little wide at the top and bottom. This is to be planed off later when the glue is hard and, when the fit is perfect, glue and brad them in place. Fit and secure one side at a time and let the glue harden over night. Then trim at the bow so that the other plank may come flat over the stem piece. After the glue is hard

8TH OPERATION.

FIG-67.

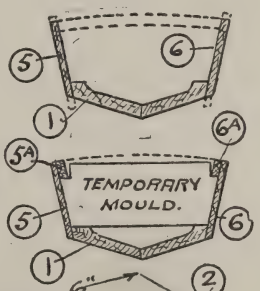


9TH OPERATION.

FIG-68.

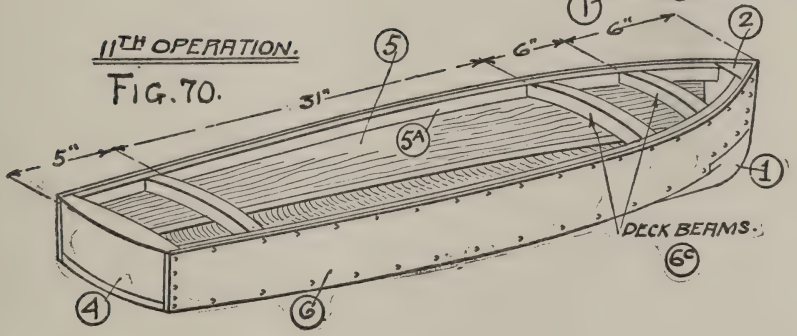
10TH OPERATION.

FIG-69.



11TH OPERATION.

FIG.70.



trim the sides aft to suit the stern piece and forward to suit the stem and the top and the bottom to suit the top of moulds and the bottom block respectively. Drive a couple of brads, as shown, part way into the temporary moulds through the sides; remove them and plugs the holes when these moulds are removed.

Operation Nine—Fig. 68: Plane the upper edge of the side planks to conform to the crown of the transom and the deck beams, the deck beams having the same crown as the top of transom. Bevel the bottom edges of the planks to suit the bottom bevel.

Operation Ten—Fig. 69: Fit the clamps 5-A and 6-A and fasten them to side planks from the inside. Use brads for this work.

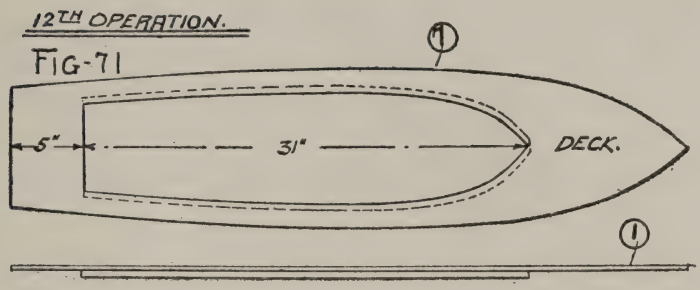
Operation Eleven—Fig. 70: Fit the deck beams, 6-C, and fasten them in place. Then remove the temporary moulds.

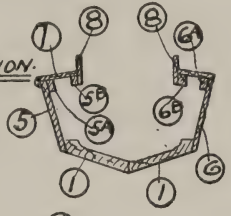
Operation Twelve—Fig. 71: Fit the deck, piece No. 7, to the boat and cut out the section for the cockpit. Brad the carlings 5-B and 6-B to underside of the deck in line with the cockpit.

Operation Thirteen—Fig. 72: Fasten the deck to the boat. Brad it to the stem, transom, clamps and deck beams. Smooth off the outer edge to conform to the sides of the boat and brad in place both half rounds.

Operation Fourteen—Fig. 73: Fit the coamings 8 and fasten them in place with brads and glue; slightly countersink all brads and sandpaper and finish the coamings smooth.

Operation Fifteen—Fig. 74: Make and secure the boiler, engine and burner bearers as shown. After the rudder, piece 9, is fitted, it should be removed


12TH OPERATION.
FIG-71
5"
31"
DECK.


13TH OPERATION.
FIG.72.

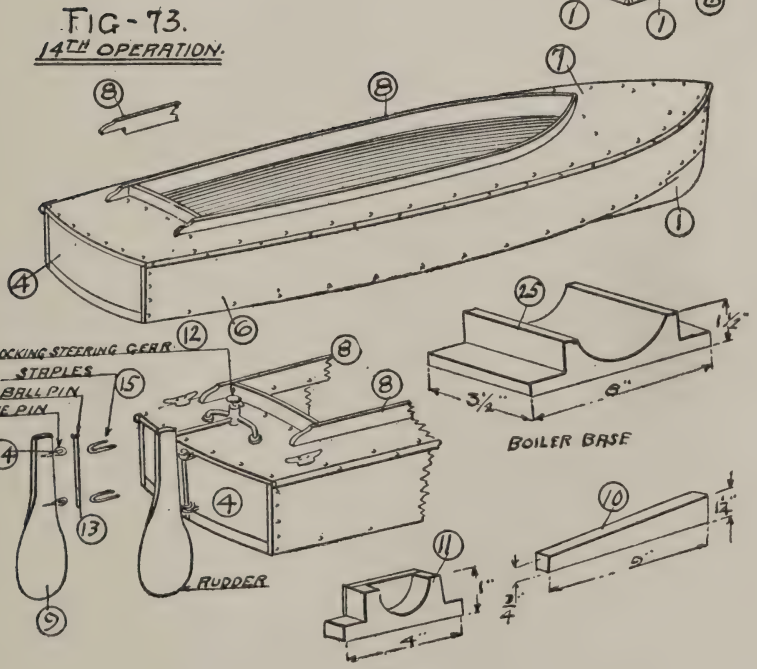
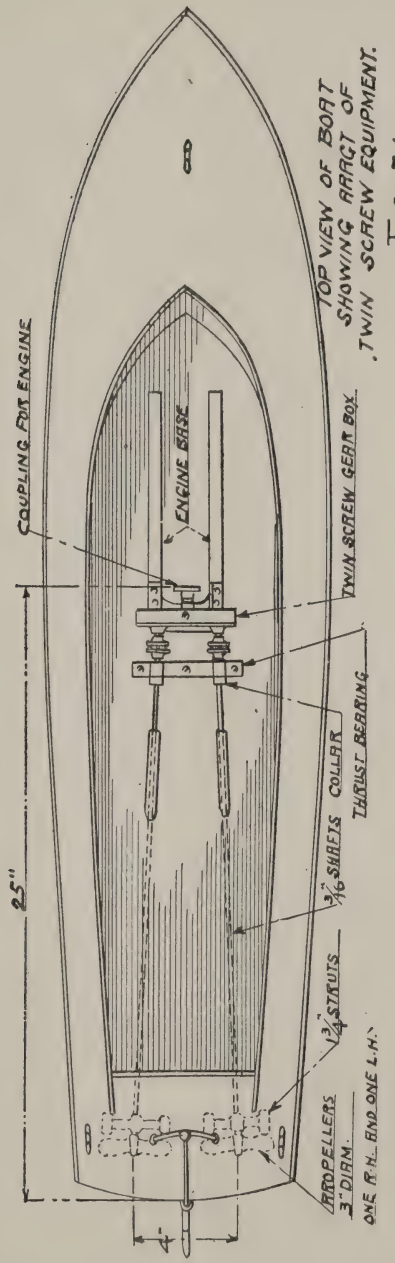


FIG-73.
14TH OPERATION.
LOCKING STEERING GEAR
STAPLES
BALL PIN
EYE PIN
RUDDER
BOILER BASE

from the boat and finished, (painted or varnished), separately. Fit the motor-base block 10. Paint and finish boat. Force the brass shaft tube, piece 19, into the shaft hole in the bottom of the boat, and cover faying surface of the palm of this with thick paint or white lead before the tube is shoved all the way in. The palm is made fast to the bottom of the boat with four small countersink brass screws. Be sure that the tube is exactly parallel with the fore and aft center line of the boat as viewed from the bottom up. The white lead helps to make the joint between the boat and the metal palm water-tight. Fit and secure the strut, piece 17, and solder the propeller to the shaft. Cut the shaft to the proper length to suit and install the boiler, burner and motor. The boat is then ready to run.

Read the general chapters because they explain fully the painting, finishing, soldering, gluing, bradding, and every general point which one should know to do the job properly.

One more thing that is important. The shaft must be lined up perfectly, because it has a bearing in the shaft strut, piece 17, and in the shaft tube, piece 19, and at the motor. If there is a bend in the shaft, it will turn hard and much power will be lost. Be careful also not to bend the shaft. First push the shaft tube into the hole in the bottom of the boat, then insert the shaft and note whether or not it turns perfectly free. It must turn just as freely when permanently fitted in the other bearings. In lining up the motor or engine on the bearers, arrange them so that the shaft, when pushed up through the tube toward the motor, lines up perfectly with the connection on



TOP VIEW OF BOAT SHOWING ARRGT OF TWIN SCREW EQUIPMENT.

FIG. 74.

the power plant, without forcing the shaft in any direction. Then mount the strut, piece No. 17, on the outboard portion of the shaft and slide it fore and aft until it touches the bottom of he boat at the proper distance from the stern, but be careful that this does not force the shaft or cause it to bind. The strut arms may be bent slightly apart or pushed together in order to make the strut shorter or longer as required. Press the palms of the strut firmly against the bottom of the boat before securing, when you have found the proper place to secure it, rotate the shaft and note if it is perfectly free. A slight shift must be made if there is any binding. Be sure also to have the shaft directly under the fore and aft center line of the boat. The propeller and rudder must both be located centrally when viewing the finished boat from aft.

Note the chapter on painting, but do not put the boat in the water until it is well primed with paint. With the large boiler, the four-cylinder motor designed for this boat is so powerful that it is able to drive two propellers. It will not give as much speed as one propeller of the proper size, due to the loss from friction in the gear drive and the extra shaft, but some builders like to see this powerful looking boat fitted with two propellers. Such an outfit is indicated in Fig. 74. Arrangements have been made with firms to supply this fitting, which is called the twin screw gear drive.

CHAPTER X

A THIRTY-SIX-INCH RACING HYDROPLANE
(Semi-Blocked Type)

This chapter deals with the construction of a thirty-six-inch boat of the semi-block type, and powered with a two-cylinder high speed racing steam engine, an eighty-one square inch tubular high pressure steam boiler which is fired with a light gasoline blow torch.

Before proceeding with the construction of this boat boat it is absolutely necessary to read all of the general chapters as much information in connection with the construction will be found there.

This boat is light and rigid and has attained a speed of about 9 miles an hour. When completed it appears similar to the thirty-six-inch hydroplane of the framed type, but the construction is simpler and well within the ability of the average builder.

The construction of this boat is based on the same principle as the twenty-four-, thirty- and forty-eight-inch boats, (semi-block type). The details of construction are in every respect similar to the forty-eight-inch racing hydroplane of the semi-block type, and the procedure for construction and the part numbering are also identical. By following the instructions for forty-eight-inch boat, sufficient data will be secured. The boat is one foot shorter than the forty-eight-inch model and consequently all other dimen-

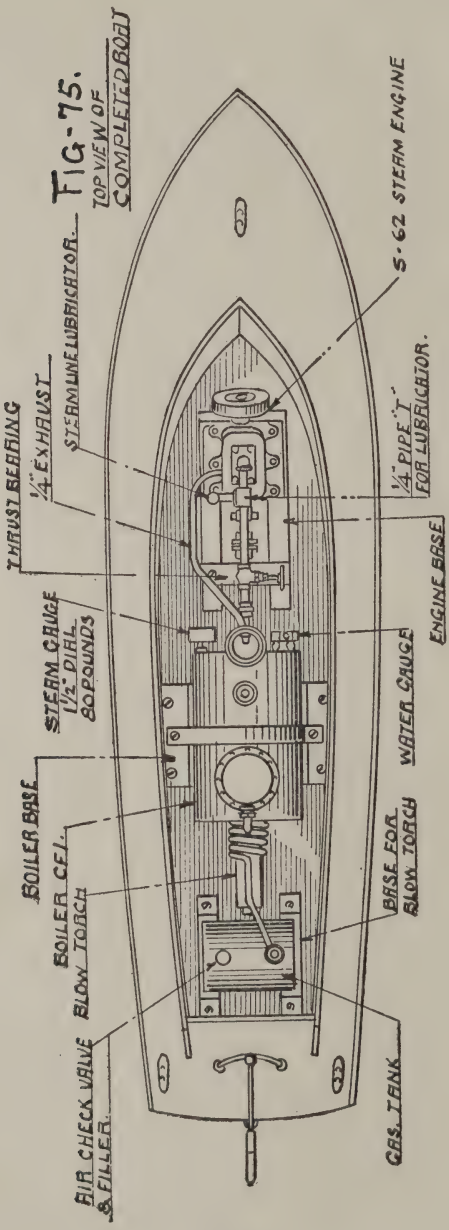


FIG. 75.
TOP VIEW OF COMPLETED BOAT
5 · 62 STEAM ENGINE
¼" PIPE "T" FOR LUBRICATOR.
ENGINE BASE
WATER GAUGE
BASE FOR BLOW TORCH
GAS TANK
AIR CHECK VALVE & FILLER
BOILER BASE
BOILER CEL.
BLOW TORCH
STEAM GAUGE 1½ DIAL 80 POUNDS
¼" EXHAUST
STEAM LINE LUBRICATOR
THRUST BEARING

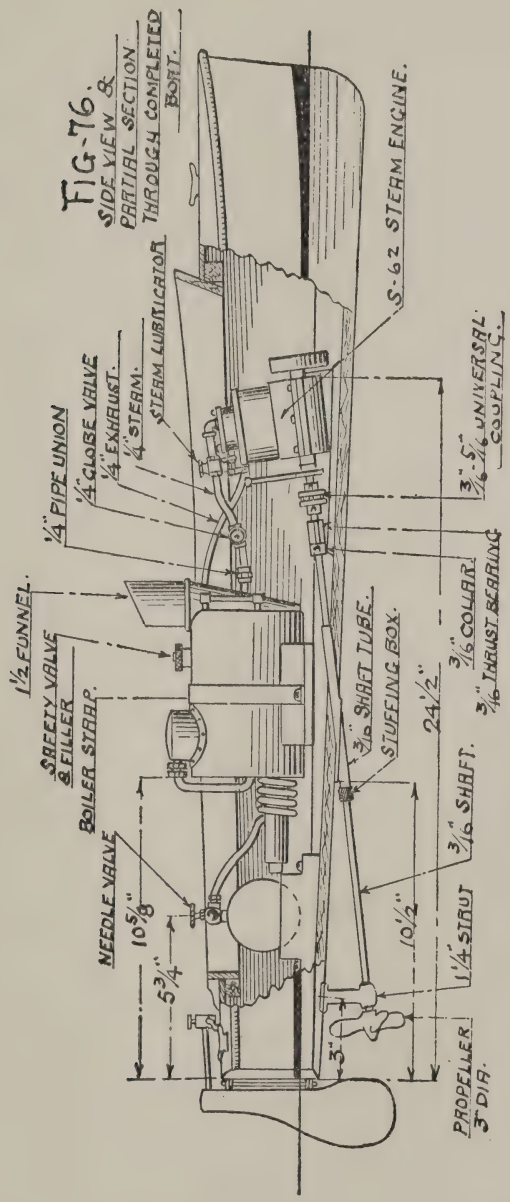
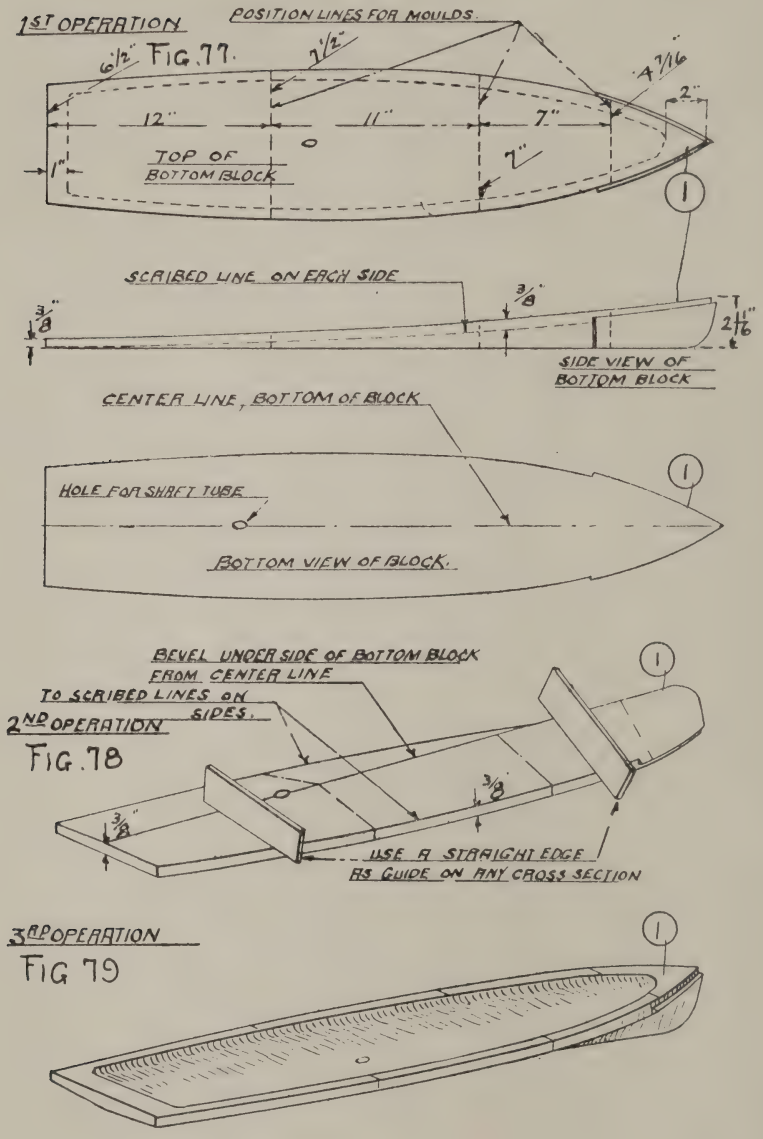
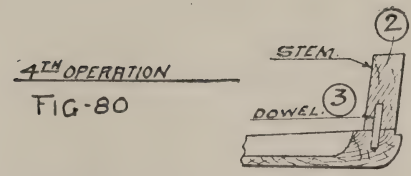


FIG-76.
SIDE VIEW & PARTIAL SECTION THROUGH COMPLETED BOAT.
S-62 STEAM ENGINE.
1/4" PIPE UNION
1/4" GLOBE VALVE
1/4" EXHAUST.
1/4" STEAM.
STEAM LUBRICATOR
1/4 FUNNEL.
SAFETY VALVE & FILLER
BOILER STRAP.
NEEDLE VALVE
10 5/8"
5 3/4"
3/16" SHAFT TUBE.
STUFFING BOX.
24 1/2"
3/16" COLLAR
3/16" THRUST BEARING
3" 5/16" UNIVERSAL COUPLING.
10 1/2"
3/16" SHAFT.
1/4" STRUT
3"
PROPELLER 3" DIA.


1ST OPERATION
POSITION LINES FOR MOULDS
6½"
FIG. 77.
7½"
4 7/16"
2"
12"
11"
7"
1"
TOP OF BOTTOM BLOCK
7"
1
SCRIBED LINE ON EACH SIDE
3/8"
3/8"
2 11/16"
SIDE VIEW OF BOTTOM BLOCK
CENTER LINE, BOTTOM OF BLOCK
1
HOLE FOR SHAFT TUBE
BOTTOM VIEW OF BLOCK.
BEVEL UNDER SIDE OF BOTTOM BLOCK FROM CENTER LINE TO SCRIBED LINES ON SIDES.
2ND OPERATION
FIG. 78
1
3/8"
3/8"
USE A STRAIGHT EDGE AS GUIDE ON ANY CROSS SECTION
3RD OPERATION
FIG 79
1


4TH OPERATION
FIG-80
STEM
DOWEL
2
3

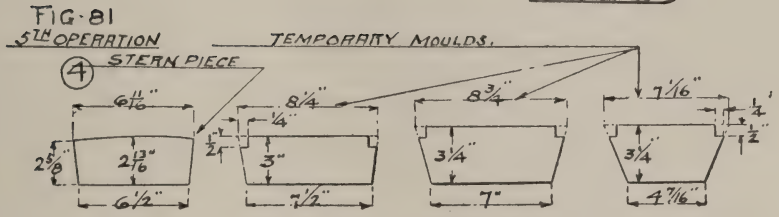


FIG-81
5TH OPERATION
TEMPORARY MOULDS.
4
STERN PIECE
6 11/16"
8 1/4"
8 3/4"
7 1/16"
1/4"
1/2"
2 5/8"
2 13/16"
3"
3 1/4"
3 1/4"
6 1/2"
7 1/2"
7"
4 7/16"

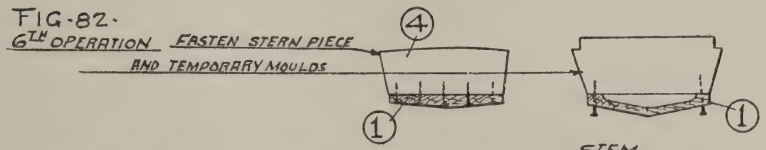
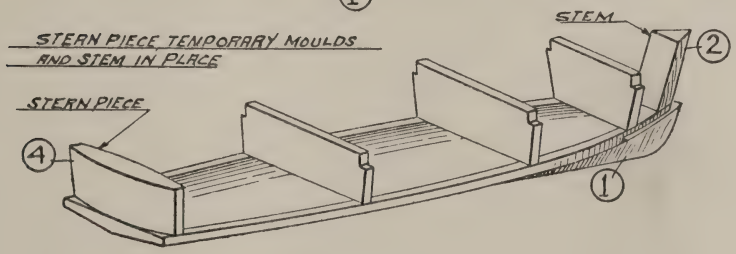


FIG-82.
6TH OPERATION
EASTEN STERN PIECE
AND TEMPORARY MOULDS
4
1
1

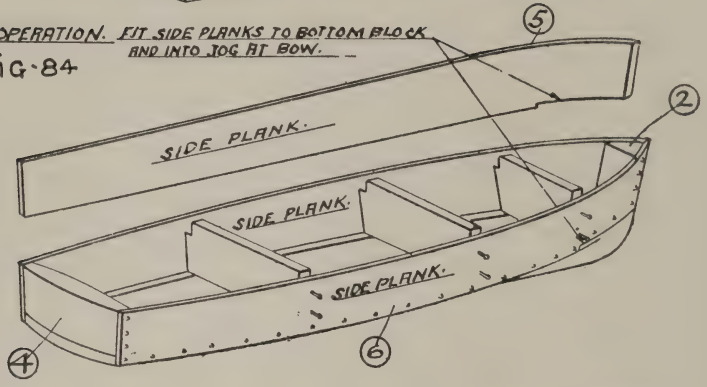

STEM
STERN PIECE TEMPORARY MOULDS
AND STEM IN PLACE
STERN PIECE
2
4
1

7TH OPERATION.

FIG-83.

8TH OPERATION. FIT SIDE PLANKS TO BOTTOM BLOCK AND INTO JOG AT BOW.

FIG-84

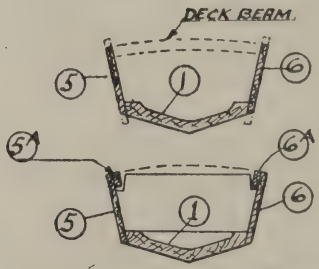


9TH OPERATION.

FIG 85

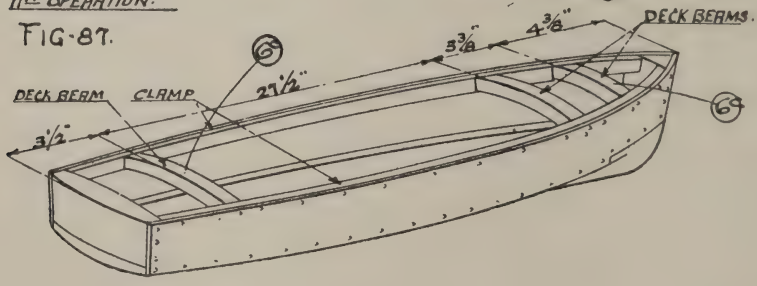
10TH OPERATION.

FIG-86



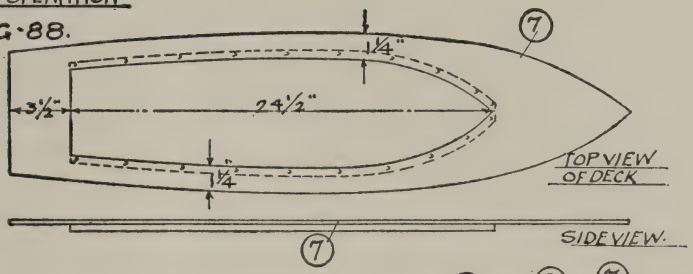
11TH OPERATION.

FIG-87.



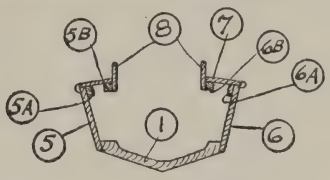
12TH OPERATION

FIG. 88.



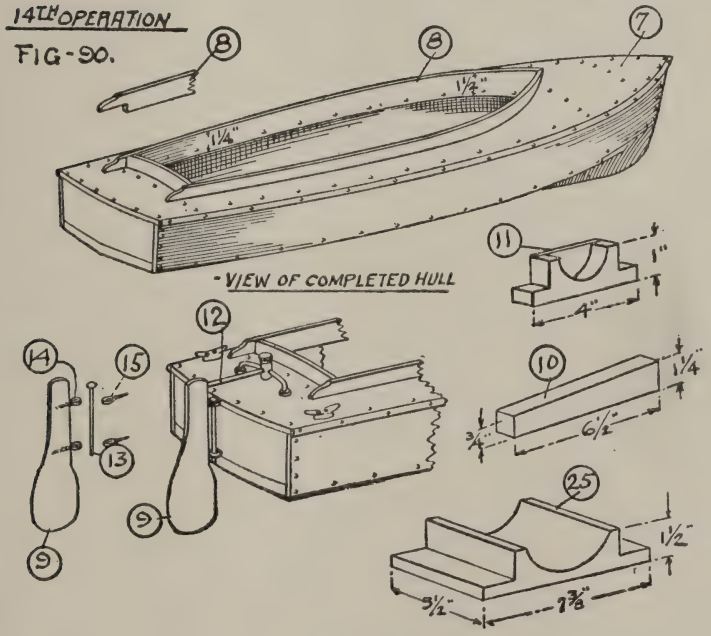
13TH OPERATION

FIG. 89.



14TH OPERATION

FIG. 90.



sions are smaller. These differences are clearly shown in the drawings of the two boats.

The power plant of the thirty-six-inch boat is smaller than that of the forty-eight-inch but exactly the same as that used for the thirty-six-inch framed type racing hydroplane. Follow the instructions for the installation of the power plant of the framed type thirty-six-inch boat.

For painting and finishing, gluing, bradding, soldering and every general point that one should know to properly do the job, read all of the general chapters.

The operations of the construction of this boat are like the forty-eight-inch boat run from 1 to 14 inclusive, but the figure numbering is necessarily different. The figures running from 75-90.

CHAPTER XI

A THIRTY-SIX-INCH RACING HYDROPLANE— (Framed Type)

This racing hydroplane is thirty-six inches long and of the frame type. It is powered with a two-cylinder high speed racing steam engine, an eighty-one square inch tubular high pressure steam boiler and fired with a light gasoline blow torch.

Before proceeding with the construction of this boat it is absolutely necessary to carefully read the introduction and all of the general chapters as much information in connection with the construction will be secured there.

The boat is extremely light and rigid and has attained a speed of ten miles per hour. It is built exactly like a large racing boat of this type and represents the highest type of the model makers' art, but if the simple picture instructions are carefully followed, anyone of average intelligence will have no difficulty in constructing the boat in a creditable manner.

The following is a list of material forming the hull. The numbers and names assigned to the several parts listed in the following table will be carried through-

out the description for the ready identification of the parts.

LIST OF MATERIALS

No.	Name	No.	Name
1.	Keel	19.	Coamings
2.	Bow piece	20.	
3.	Stem	21.	Stern coamings
4.	Frames	22.	Half round
5.		23.	Beam
6.		24.	Blow torch
7.		24A.	Engine
8.	Transom	25.	Boiler
9.	Clamps	26.	Locking steering gear
10.		26A.	Rudder
11.	Chines	27.	Cleats
12.		28.	Chock
13.	Side planks	29.	Propeller
14.		30.	Strut
15.	Bottom planks	31.	Shafting
16.		32.	Shaft tube and stuffing box
17.	Deck	33.	Universal shaft coupling
18.	Carlings	34.	Thrust bearing
		35.	Thrust bearing collar

If you so desire you may purchase especially selected and treated materials, waterproof glued, and partly finished. Arrangements have been made with firms specializing in this type of material to furnish these parts at a price about equal to that which you would pay for material in the open market that was not specially treated, selected or partly shaped.

The following work will have been done for you in the fabricated material.

Piece 1—Keel. Will come finished one-half-inch square, the one-quarter-inch shaft hole bored to the proper angle.

Piece 2—Bow Piece. Shaped as indicated in Fig.

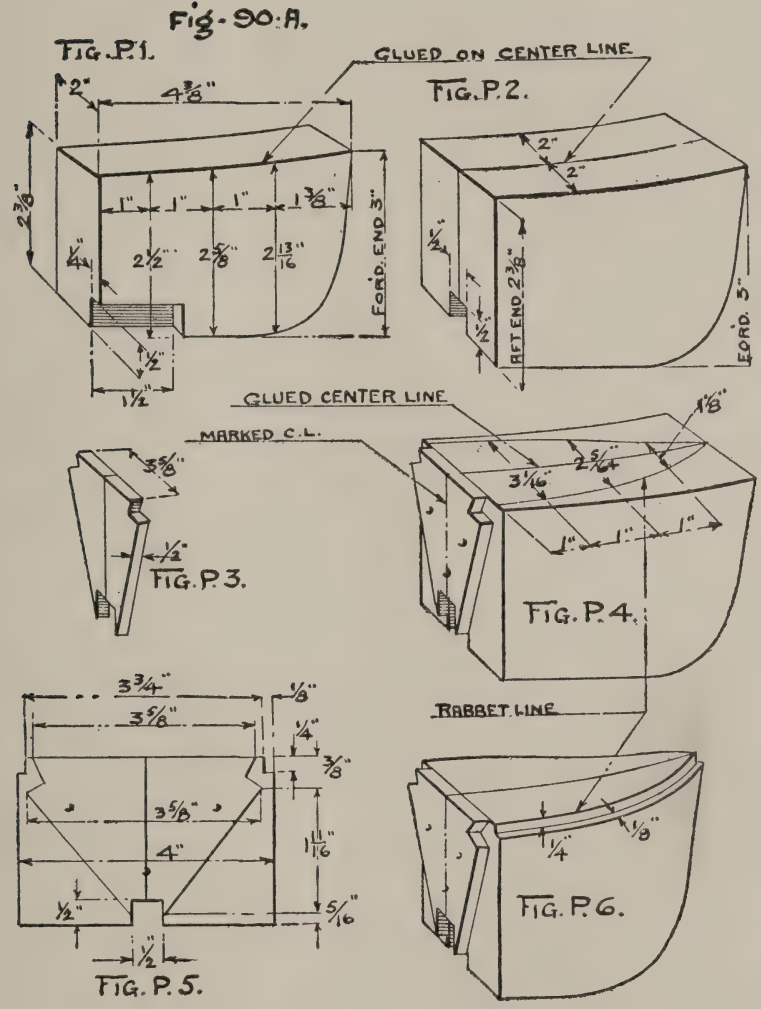


Fig. 90. A.
FIG. P. 1.
2"
4 3/8"
2 3/8"
1"
1"
1"
1 3/8"
1/4"
2 1/2"
2 5/8"
2 13/16"
FORD. END 3"
1/2"
1 1/2"
GLUED ON CENTER LINE
FIG. P. 2.
2"
2"
1/4"
1/2"
AFT END 2 3/8"
FORD. 3"
GLUED CENTER LINE
MARKED C.L.
3 5/8"
1/2"
FIG. P. 3.
1/8"
3 1/16"
2 5/16"
1"
1"
1"
FIG. P. 4.
3 3/4"
3 5/8"
1/8"
1/4"
3/8"
3 5/8"
4"
1 11/16"
1/2"
5/16"
1/2"
FIG. P. 5.
RABBET LINE
1/4"
1/8"
FIG. P. 6.

P-6. This piece is fairly hard to make without power tools because it should be accurate. It consists of three pieces put together with waterproof glue and carefully rabbeted to receive the side and bottom planks. It is also slotted at the bottom to receive the forward end of the keel. All of these operations must be a perfect fit to insure water-tightness, similarity of both sides and the professional appearance of the boat.

Piece 3—Stem. Cut to the proper length and bevelled to match up with the bow piece. It is bored longitudinally with a one-quarter-inch hole to receive the securing dowel.

Pieces 4, 5, 6, 7—Frames. Cut to exact dimensions, accurately notched to receive the keel, chines and clamps. They are made from three-ply birch veneer secured with waterproof glue, each of the three lifts running in a different direction to prevent warping or splitting.

Piece 8—Transom. Dressed and cut to the proper size and thickness ready to receive the keel, chines and clamps and is ready to cut the proper curve at the top for the crown of the deck.

Pieces 9, 10—Clamps. Cut to the proper size, $\frac{3}{8}$ in. x $\frac{3}{8}$ in., and steam bent to shape. The material is long enough to cut to the proper length and fit.

Pieces 11, 12—Chines. (Same as clamps.)

Pieces 13, 14—Side Planks. Steam bent to shape and made from three-ply waterproof birch veneer, each lift running in different directions, to prevent warping or splitting.

Pieces 15, 16—Bottom Planks. (Same as side planks.)

Piece 17—Deck. This comes in flat three-ply birch veneer board, of sufficient size to cut down to the deck size.

Piece 18—Carlings. Material to make these.

Pieces 19, 20—Coamings. Steam bent of mahogany cut to shape of sufficient size to cut from.

Piece 21—Stern Coaming. Mahogany with sufficient material.

Piece 22—Half Round. Mahogany with sufficient material.

Piece 23—Beam. Material to make this.

Screws, brads, and waterproof glue powder, sufficient to do the job.

Should you desire to make these parts complete yourself, the following preliminary work will be necessary after you purchase the material from a source of your own selection.

All mahogany to be kiln-dried. All white pine to be that known as pattern-makers' pine, kiln-dried. All material for frames to be three-ply birch veneer $\frac{3}{16}$ in. thick, made up with waterproof glue, each lift to be disposed in a different direction to prevent its warping or cracking. All veneering for the bottom, sides and deck to be of the same, except that it is $\frac{3}{32}$ in. thick. One piece of dressed mahogany, $\frac{1}{2}$ in. thick by 40 in. long and 6 in. wide will be ample to cut the following:—

Piece 1,	Keel	$\frac{1}{2}$" x $\frac{1}{2}$" x 36" long
Pieces 9- 10,	2	Clamps	$\frac{3}{8}$" x $\frac{3}{8}$" x 40" long
Pieces 11-12,	2	Chines	$\frac{3}{8}$" x $\frac{3}{8}$" x 40" long
Piece 22,	2	Half Rounds	$\frac{3}{16}$" x $\frac{3}{16}$" x 40" long
Piece 24,	2	Rudder	

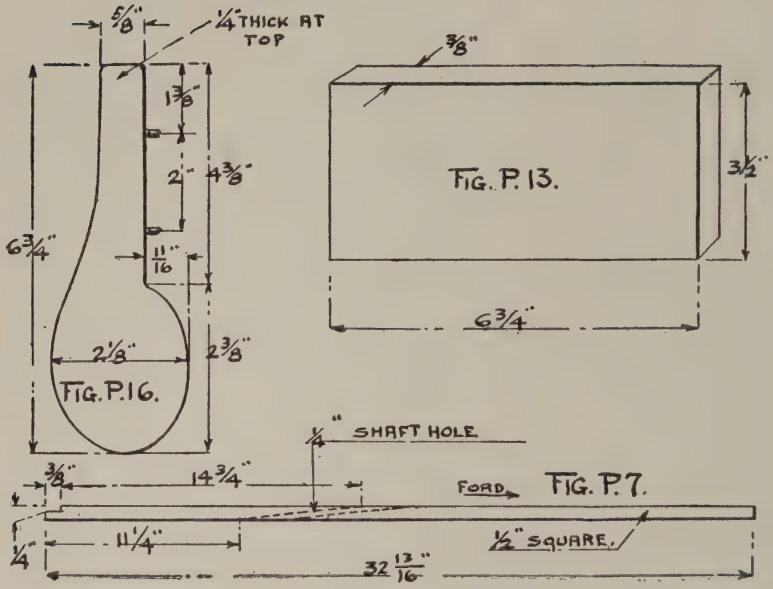
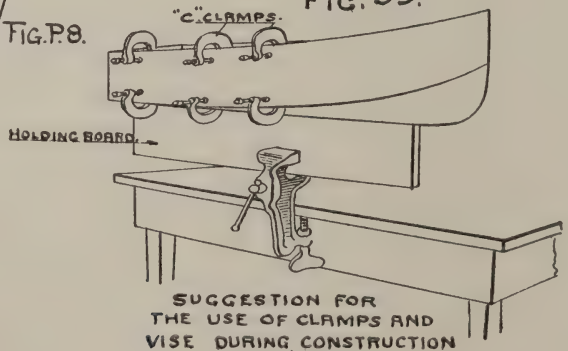


FIG. 93.



SUGGESTION FOR THE USE OF CLAMPS AND VISE DURING CONSTRUCTION

One piece of pattern-makers' white pine, kiln-dried, 2 in. thick by 3 in. wide by 18 in. long will be ample to cut the following:

Piece 2, 2 Bow Pieces
Piece 3, Stem Piece
Piece 23, Beam
Piece 18, Carlings

One piece of dressed mahogany $\frac{3}{16}$ in. thick by 40 in. long by 6 in. wide will be ample for pieces 19, 20, 21 (Coamings).

One piece of $\frac{3}{16}$ in. three-ply birch veneer 11 in. by 15 in. will be sufficient to cut.

Pieces 4, 5, 6, 7—Frames (see Plate 2).

The deck piece 17 may be cut from one piece $\frac{3}{32}$ in. three-ply birch veneer 37 in. by $9\frac{1}{2}$ in.

Two pieces of three-ply birch veneer $\frac{3}{32}$ in. thick by 38 in. by 5 in. will do for pieces 13, 14—The sides.

Pieces 15, 16—Bottom. Two pieces the same as the sides except 36 in. by $4\frac{1}{2}$ in. each. For those who do not desire to avail themselves of the fabricated material the following will help over some of the most difficult points in the preliminary shaping of these parts.

The bow piece (piece 2) is made of three pieces. From white-pine, dressed stock, 2 in. thick by 3 in. wide by 18 in. long, cut two pieces as indicated in Fig. P-1. Glue these together as indicated in Fig. P-2. After the glue is hard, cut out the pieces, Fig. P-3, and glue and brad them as indicated in Fig. P-4, then rabbet the piece as indicated in Fig. P-6, in order to receive the keel and the side planking. Piece P-5

is a rear view of the bow piece. Keel piece 1 is dressed to $\frac{1}{2}$ in. x $\frac{1}{2}$ in. x 36 in. long. Bore the shaft hole, ($\frac{1}{4}$ in. diameter), as per dimensions in Fig. P-7.

Stem Piece—Piece 3. Cut and bore as per Fig. P-8.

Frames—Pieces 4, 5, 6, 7. Lay out and cut them with a scroll saw as shown in the full-size templates, Figs. P-9, P-10, P-11, P-12.*

Transom—Piece 8. Cut as Fig. P-13.

Clamps—Pieces 9, 10. Cut from the mahogany stock two pieces 40 in. by $\frac{3}{8}$ in. by $\frac{3}{8}$ in. and steam bend them to fit around the frames when they are cut and set in place.

Chine—Pieces 11, 12. Same as clamps.

Side Planks—Pieces 13, 14. Steam bend to the shape of the boat after the boat is in a state of completion as indicated in operation No. 5.

Bottom Planks—Pieces 15, 16. Are the same as the side planks. Coaming pieces 19 and 20 are steam bent to shape after the boat is in condition. Operation No. 8.

Rudder—Piece 26A. Is cut to shape as indicated in Fig. P-16.

All figures marked with P, as P-1 to P-16 inclusive, represent preliminary operations necessary to prepare the material to start the boat on the same footing with those who purchase it fabricated or partly shaped. We are now ready to start building.

Progressive picture drawings from Operation One to Operation Ten inclusive show clearly the different stages of the work. They will now be described in proper order, giving each step and the best way to undertake each feature in a similar manner to that

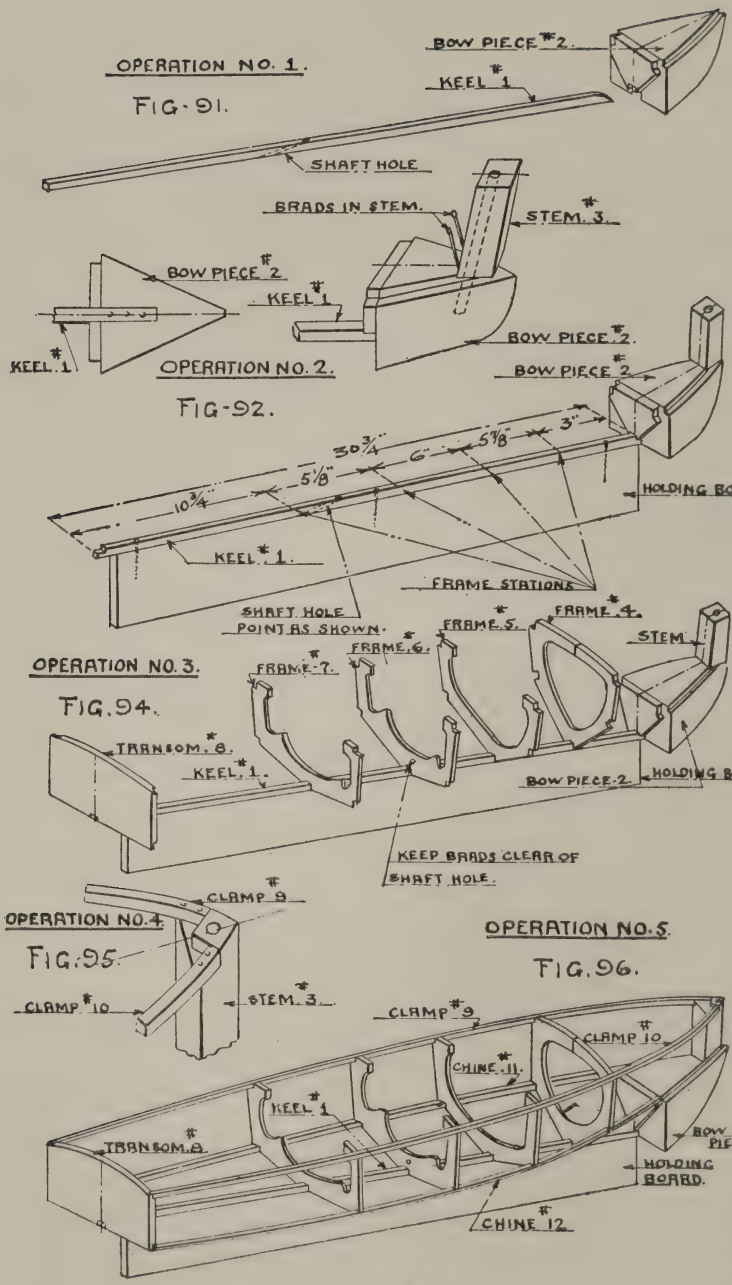
* Folding plate in pocket.

followed in the Boucher shops and in manual training classes. When reference is made to a glued joint, screw connected or bradded, it will be assumed that you have familiarized yourself with the procedure as covered in the general chapters of the book.

Operation One—Fig. 91: Read all the general chapters. Be careful and take plenty of time. Do not cut or trim anything until you are sure you are right. Fit each piece in place carefully and hold it temporarily with C clamps. Carefully mark each piece before cutting and examine the faying surfaces to see that they make perfect contact before applying the glue and bradding.

The keel is $\frac{1}{2}$ in. square and about 36 in. long and the shaft hole is bored to the proper angle. Note that when the keel is turned top side up the shaft hole opening at the top is further forward than the opening at the bottom. Round off the forward end of the keel, as indicated, in order that it will fit the slot in the bottom of the bow piece. See that the shaft hole slants in the proper direction.

Operation Two—Fig. 92: Be careful and do not rush the work. Fasten the keel to the bow-piece and glue and brad it in place. Use three long light brads as indicated. Place a mark on top of the keel $30\frac{3}{4}$ in. aft of the after face of the bow piece and square the spot, top and one side. Then cut the keel with a back-saw at the point marked. Next notch the half-depth of the keel and in length the thickness of the transom as indicated. Mark the frame stations on top of the keel as indicated by dimensions given. Temporarily secure the keel to the holding board by 3 long screws, about as indicated, (first drill pilot


OPERATION NO. 1.
FIG. 91.
BOW PIECE *2.
KEEL *1
SHAFT HOLE
BRADS IN STEM.
STEM. *3.
BOW PIECE *2
KEEL *1
KEEL *1
OPERATION NO. 2.
FIG. 92.
BOW PIECE *2.
BOW PIECE *2
30 3/4"
6"
5 1/8"
3"
10 3/4"
5 1/8"
HOLDING BOARD.
KEEL *1.
FRAME STATIONS
SHAFT HOLE POINT AS SHOWN.
FRAME *5.
FRAME *4.
STEM
FRAME *6.
FRAME *7.
OPERATION NO. 3.
FIG. 94.
TRANSOM. *8.
KEEL *1.
BOW PIECE *2.
HOLDING BOARD.
KEEP BRADS CLEAR OF SHAFT HOLE.
CLAMP *9
OPERATION NO. 4.
FIG. 95.
CLAMP *10
STEM *3.
OPERATION NO. 5.
FIG. 96.
CLAMP *9
CLAMP *10
CHINE *11.
KEEL *1
TRANSOM. *8.
BOW PIECE
HOLDING BOARD.
CHINE *12

holes in the keel and countersink for the head of the screw, to prevent the screws splitting the keel). The holding board should be a piece of pine about 30 in. long, 1 in. thick and 6 in. wide. The top edge is to be smooth and true and the board to be free of twists. When securing the keel to this board be sure, if there is any slight twist in the keel, that you secure it to the holding board in a manner to straighten it. The keel must be pulled straight and true. The holding board is, of course, only a temporary expedient for convenience in holding the boat in a vise as shown in Fig. 93. Secure the stem to the bow-piece and glue and brad it as shown. When the glue is hard, (8 hours), insert a $\frac{1}{4}$ in. bitt in the hole previously bored in the stem piece, and with a brace bore the hole down into the bow-piece about $1\frac{1}{2}$ in., withdraw the drill or bitt and blow out the shavings. Be careful in the boring operation not to break the bradded and glued joint. A $\frac{1}{4}$ in. diameter dowel furnished with the fabricated parts should be covered with waterproof glue, this glue also being put in the hole and the dowel is then pushed home or tapped into the hole. When the glue is set the stem-piece will be held securely.

Operation Three—Fig. 94: Be extremely careful. Place frames 4, 5, 6, 7 in place on the keel directly over the marks previously made, and drill two pilot holes with a drill smaller than the brads to be used. Each hole goes down through each frame and slightly into the keel. Keep the brads far enough apart on frames 6 and 7 so that they will not interfere with the shaft hole. This is highly important and if not done properly it will be necessary later on to drill them out to allow the propeller shaft to be installed.

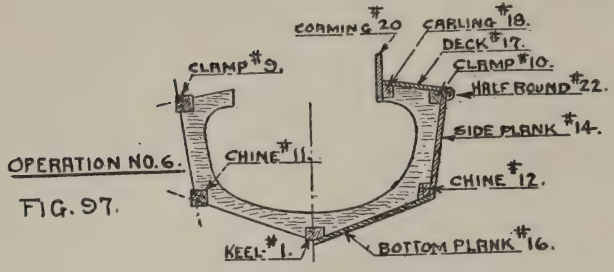
Operation Four—Fig. 95: Cut the stem to receive the clamps. This can be done with a back-saw and chisel. First lay the clamps in place, cut the notch deep enough to allow the top of the clamps to come flush with the top of the stem. These clamps will not be bradded in place yet, but when they are, drive the heads of the brads about $\frac{1}{16}$ in. below the surface so the edge of your tools will not be damaged. The stem-piece is now notched out to receive the clamps, but it is square in cross-section, instead of wedge shaped as it must be and as is indicated in the sketch.

Operation Four. The stem must be chiseled and planed down at the bottom so it will match, (Fig. 95), with the top of the rabbet, cut in the bow-piece to receive the side boards, and line up with the flare of the bow at the deck line. When the stem is properly bevelled it will have a slight outward flare toward the top when viewed from aft. The best way to shape the stem piece is as follows. First cut the landing for the clamps, start forward and see how they fit into the landing cut for them in each frame. Clamp them in place, both sides at once, otherwise you will pull the frames crooked. By bending them both in at once the pressure is equal and there is no tendency to displace the frames. Mark the correct length to fit into the notch cut into the transom and saw to this length. Glue them at the stem-piece and at the transom and brad in place also. Forward, at the stem-piece, pull the clamps in or out, until a line passed along the top outboard edge and carried forward cuts the vertical center line of the stem-piece at the fore and aft center line (see Fig. 95 of operation 4). When the glue is hard, plane and chisel off the superfluous portion of

the square stem until it resembles the stem shown in operations 4 and 5, so that the side planks when fitted in place will touch evenly over the entire surface of the stem and at the same time lay fair and true into the fore and aft rabbet.

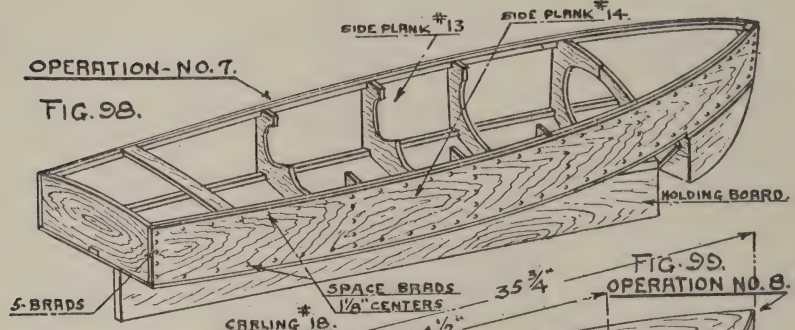
Operation Five—Fig. 96: Be careful. Finish the clamp and bend in the chine. Start forward and work aft, both at once, fit the same as described for the clamp, and secure the forward end in the notch cut to receive it in the transverse block of the bow-piece. Both the chines and the clamps pass over the notches cut in the frames to receive them, but they are not yet bradded to them. Check the outer ends of the frames and see that they are at equal distance from the fore and aft center-line and parallel to each other. They must be square to the keel in both directions, vertically and transversely. If they are not, pull them so, and then drive one brad into each frame from the chines and clamps. Set the heads of the brads far enough into the wood to prevent hitting them with a chisel or plane. Use a small nail set for this work.

Operation Six—Fig. 97: Be careful. Bevel the chines and clamps to receive the bottom, side-boards and deck. See Fig. 97. The portion of the clamps and chines extending beyond the dotted line in this figure must be cut away so these members line up with the frame line. All as indicated on the starboard side of the figure where the planking is fitted. The best procedure for effecting this is as follows. Trim the chines and clamps locally in the way of the frames first, so that they will have the proper bevel to line up with the frames. If the edge of a straightedge be laid transversely on the frame, and allowed to pass



OPERATION NO. 6.

FIG. 97.



OPERATION-NO. 7.

FIG. 98.

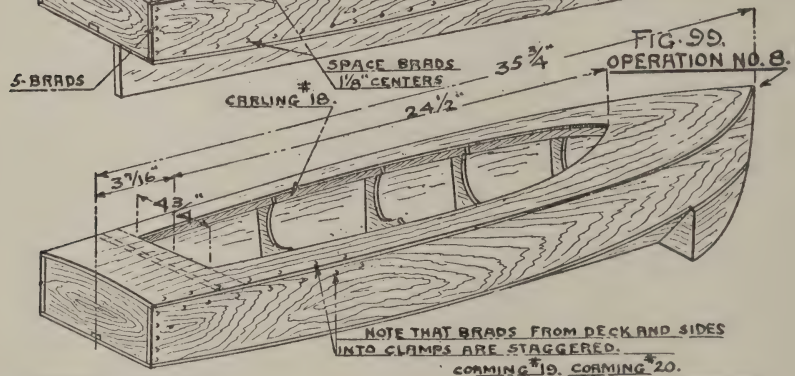
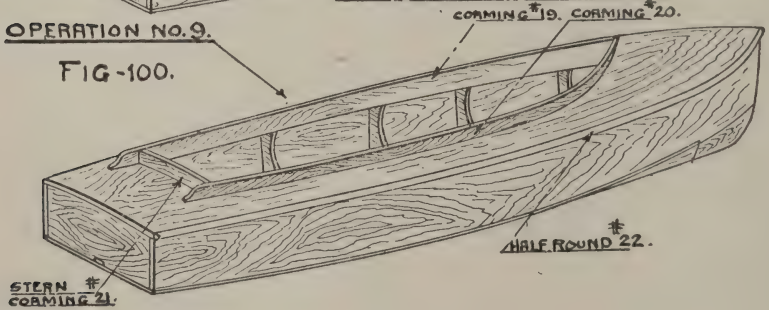


FIG. 99.

OPERATION NO. 8.

NOTE THAT BRADS FROM DECK AND SIDES INTO CLAMPS ARE STAGGERED.



OPERATION NO. 9.

FIG-100.

over the keel and chine, or the chine and the clamp, it will touch evenly on all three members without showing a gap of light. When this has been done at each frame and the transom, finish the chines, clamps and keel for their full lengths. Check every now and then with a straightedge and when they are fair and true the grooves that were originally cut in the way of the frames will have disappeared and the entire surface will be flush.

Operation Seven—Fig. 98: Fit and secure the sides, leave a little extra length and width to be finished later. The only place they must be accurately fitted at first is into the rabbet of the bow-piece. This must be a good fit because it shows and also helps to make the boat water-tight. When the fit is good, clamp the entire side in place with C clamps and again examine all parts of it, particularly the rabbet and all the faying surfaces. Make sure that it lies flat and flush on the frames, chine and clamps and if it is right, drive one brad, (part way only), through the side and into the transom and also one into the stem-piece.

Note: Always plug a hole with a small wooden stick, dipped into waterproof glue, after removing a temporary brad.

Finish the plug off flush with surface of wood after the glue is hard. Next make several pencil marks on the frame of the boat. These marks and the brads will help to get the plank back in the correct position when you have applied the glue and are ready to permanently secure the sides. Then remove the plank and apply the glue. Start to secure forward and work aft pushing the forward temporary brad in the hole

and drive it in first. Fasten the plank to the frames with C clamps until you brad it in place. Fit the after brad in place but do not drive it in yet. The plank may walk aft a little and it must be free to move a fraction of an inch or else you will have a bow in the plank which will not lay flat in one spot. The brads and fastenings will resemble Fig. 98, operation No. 7, when driven. Note how they are spaced. Repeat this for the other side of the boat, then trim off the surplus material to suit the bevel of the chines, clamps and stern. The boat is now held quite rigidly and the holding board may be removed. The screw holes must, of course, be plugged with pine plugs, dipped into waterproof glue and trimmed off flush when the glue is hard. Up to this point the boat may be held in a vise as indicated in Fig. 93.

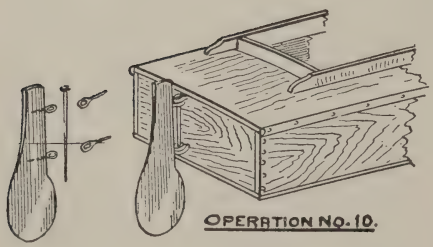
Operation Eight—Fig. 99: Fit and secure the bottom in a manner similar to the sides. The bottom is in two pieces, split down the fore and aft center at the keel. There should be a fore and aft center-line marked on the under side of the keel. This line will be exactly $\frac{1}{4}$ in. in from each outboard edge of the $\frac{1}{2}$ in. keel. The bottom boards should be trimmed so that when they are pressed down over the frames, their lower inboard edges will exactly match up with the fore and aft line on the keel, and when both the port and starboard bottom boards are fitted, their inboard edges will make good contact, in order to be watertight. After each bottom board fits, along the fore and aft line of the keel when the plank is pressed down over the frames, its forward edge must be trimmed to butt perfectly with the after edge of the bow-piece. It may be left a little longer where it

lands on the transom and chines and be trimmed, after gluing and securing. After both halves have been properly fitted and secured and when the glue is hard, carefully trim them along the bilge line until the outboard edge is true and at the same angle as the sides. Follow this also at the transom. Draw a fore and aft center line on the deck board and hold this board on the boat in the proper location. Mark in the side lines and transom line and also the shape of the cut-out for the cockpit. Drill a hole large enough to pass the blade of your scroll saw in and then saw it out nearly to the line. Finish to the line with a plane and sandpaper. Fit the carlings as indicated. Trim the outer boundary of the deck, but not to the line as this will be cut after securing to suit the exact shape and bevel of the boat. It will be noticed that the carlings are fitted intercostally between the frames, the carlings are for backing up the coamings when it is fitted. They may be fitted before the deck is secured in place and they have a slight bevel forward in order to give the coaming the proper tumble out. See Operations 8 and 9, Figs. 99 and 100.

Operation Nine—Fig. 100: Be careful. Fit and secure the coamings with glue and brads to the carlings. Cut the butt of the port and starboard coamings forward, so that they come together in a flare when viewed from the side but in a perfectly straight line when viewed from forward. Trim the bow-piece off, forward, to conform to the line of the planked portion of the boat. The glued joint at the center will be a guide for a center line. This portion of the boat is cut with a slight hollow line. It can be done best with a gouge. Go carefully and make both sides

alike. Do not dig too deep. Finish up smooth with sandpaper. It is best to finish one side at a time and then make a pair of guide templates for cutting the other side. Fit and secure the half-round. These should be cut to the proper half-round cross section before fitting, leaving the faying edge smooth and flat to match up with the sides of the boat. It may be necessary to place the forward ends into boiling water before they are fitted in order to prevent breaking. Start securing forward and work aft, using brads only. Fit the top exactly flush with the top-side of the deck or leave it a shade above and then finish it flush with sandpaper. Slightly countersink the brad heads with a small nail set. Later on these will receive putty.

Operation Ten—Fig. 101: Make the rudder, as per dimensions, and hang it on the transom, as indicated. Complete metal fittings for the rudder will be available at Boucher, Inc., if you desire to purchase them. The plan view of the complete boat, Fig. 103, and the



OPERATION NO. 10.

FIG. 101.

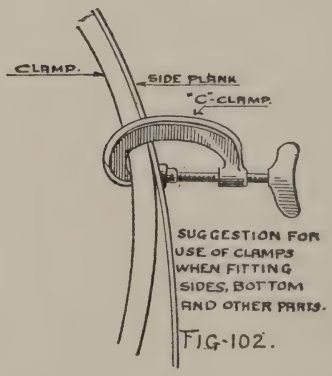


FIG. 102.

profile, Fig. 104, show the power plant and fittings in their proper places. The other suggested fittings are also shown here. It will be noted that frames 6 and 7 are shaped to receive the boiler. This, of course, gives the forward and aft location of the same. The location of the engine and the blow torch are shown. Locking steering gear 26, cleats 27, chock 28, propeller 29, strut 30, shafting 31, shaft-tube and stuffing box 32, universal shaft coupling 33, thrust bearing 34, and thrust bearing collar 35 are all stocked by Boucher, Inc., and may be had for a comparatively small cost.

The proper method of installing the shaft is as follows: First fit the palm of the shaft-tube and stuffing box to the underside of the boat in way of the outboard end of the shaft hole. Push the inboard end of the tube into the hole and if the latter is at the proper angle the palm of the tube will come flush with the bottom of the hull. Cover the faying surface of the palm and the hull with thick paint and push the palm home, securing it in place with countersunk brass screws. Be careful not to bend the tube because if it is not perfectly true it will bind the propeller shaft and make it hard to turn. Next put the propeller shaft into the tube and mount the strut on it as indicated on the profile. The strut is of soft brass and the legs may be spaced apart or pressed slightly together until it fits in the desired position. Be sure it is in the exact center and each leg is at an equal distance each side of the center line of the boat. Be sure also that the shaft is free to turn freely without binding in the least and then secure the palms with countersunk brass screws through the bottom of the

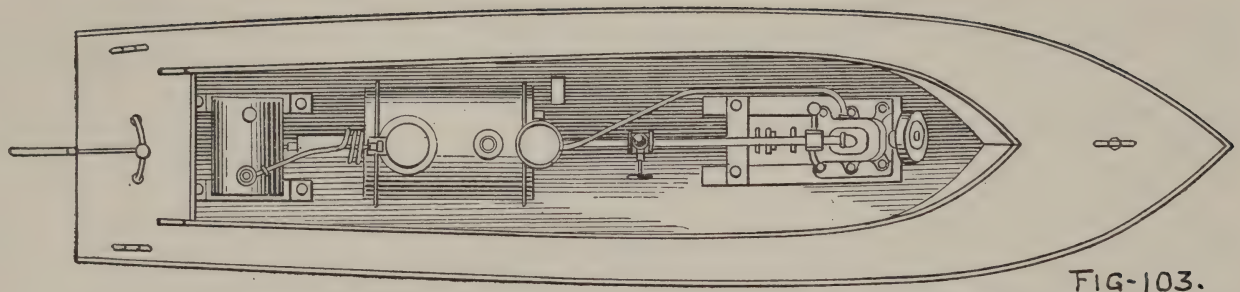
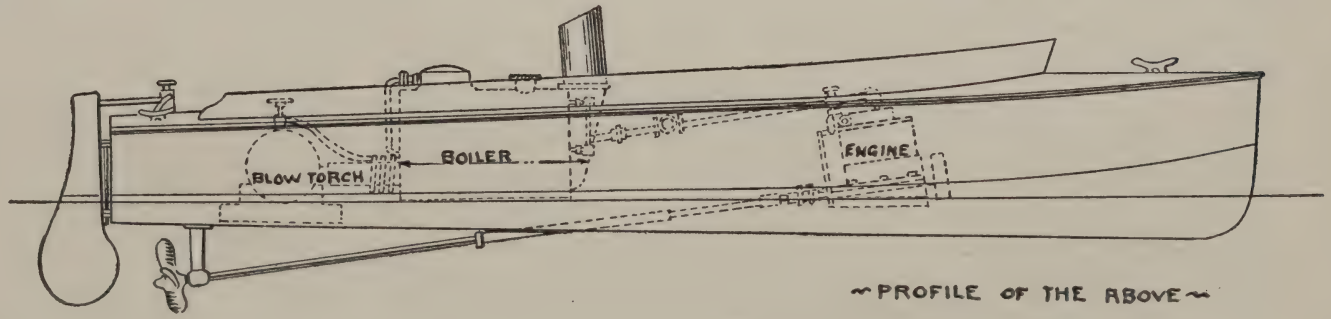


FIG-103.
~ PLAN VIEW OF BOAT COMPLETED AND FITTED WITH POWER PLANT ETC. READY TO RUN. ~



~ PROFILE OF THE ABOVE ~
FIG-104.

boat. Be careful not to bend the strut or the shaft after they are secured in place. Remove the shaft and solder the propeller to the end of the shaft. This is done by scraping the end of the shaft and the inside of the hole in the propeller to bright metal. Then heat them both over an alcohol torch, sufficiently to melt electricians' soft wire solder. Tin the end of the shaft and also the hole by wiping the end of the soldering wire over the hot metal of the shaft and wheel. Then heat it again and mount the shaft in the propeller hole, afterward allowing it to harden. The electricians' soldering wire usually has a resin flux inside of the wire which makes it hold.

Build the motor bed up until the engine is at the same angle as the shaft. Fit the thrust bearing so that it lines up with the shaft. Then cut the shaft to the proper length so that when one element of the coupling (universal coupling) is slipped over the end of the engine drive shaft and the screw is set up, the shaft (propeller) is just long enough for the other element of the coupling when mounted on this shaft to engage the engine element of the coupling. In order that the thrust or forward push of the propeller does not come on the engine bearings, a small thrust collar, No. 35, is secured to the shaft just abaft of the thrust bearing and, in this manner, all that the engine is required to do is to turn the shaft. The engine bearings would be worn out quickly if this thrust came directly on them. Details and descriptions of the power plant are incorporated in a different chapter.

CHAPTER XII

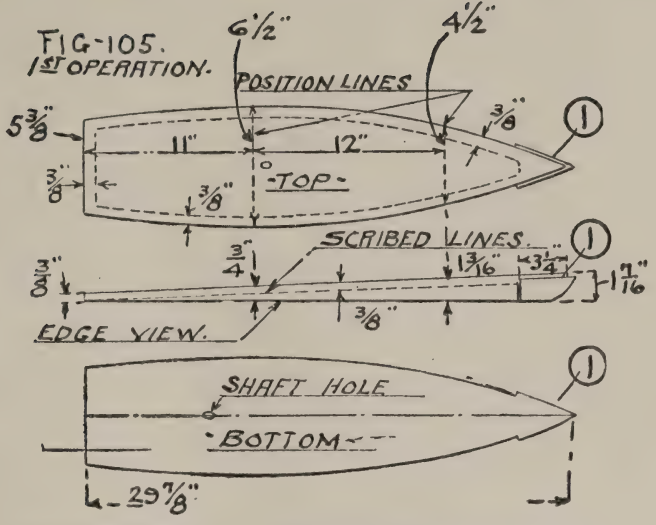
THIRTY-INCH POWER BOAT
(Semi-Blocked Type)

This chapter describes a thirty-inch power boat, which may be powered with either a steam boiler and a one-cylinder steam engine or a special spring motor which looks and performs exactly like a gasoline motor. This spring motor will run for five minutes and will drive the boat at about three miles an hour. It is equipped with a starting and stopping clutch lever. This is an ideal and reasonably priced boat and outfit. It has all the class and grace of family power boats of from 25 to 35 feet in length, and it is light and sturdy. The construction is the simplest possible and any amateur should have no trouble in building a creditable looking craft.

The construction of this boat is exactly similar to that of all the semi-block types and particularly resembles the twenty-four-inch boat, semi-block type, except that the bottom block, piece No. 1, is hollowed out a little further aft. The dimensions, of course, are all different, but the description and procedure for building is identical. Therefore it is well to follow the instructions mentioned under the twenty-four-inch boat. The parts are all numbered the same and there should be no confusion.

The steam power plant has been specially designed for this boat and its arrangement has been

FIG-105.
1ST OPERATION.



2ND OPERATION.

FIG-106.

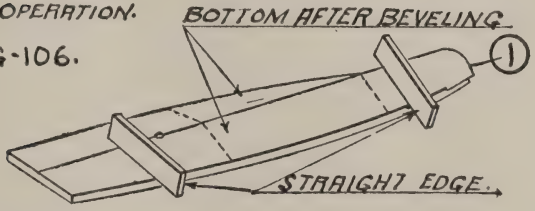
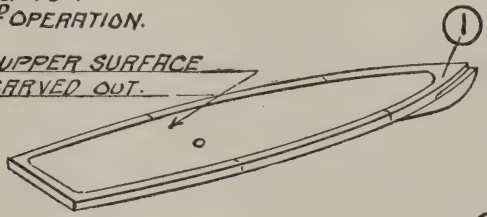


FIG-107.
3RD OPERATION.



4TH OPERATION

FIG-108

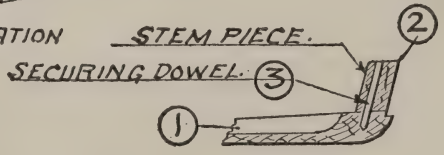
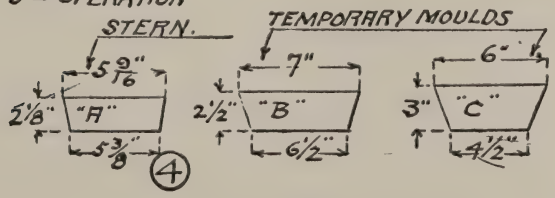
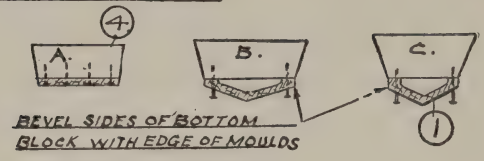


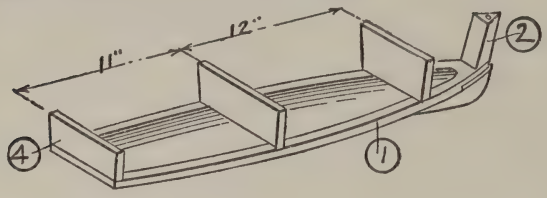
FIG-109.
5TH OPERATION



FIGS-110-111.
5TH AND 7TH OPERATIONS.

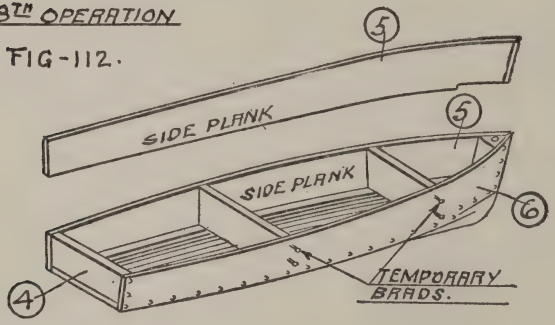


COMPLETED BOTTOM BLOCK WITH STEM STERN & MOULDS IN PLACE



8TH OPERATION

FIG-112.

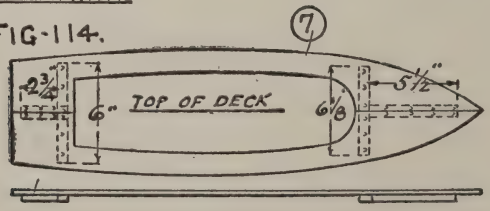


9TH OPERATION

FIG-113.

10TH OPERATION

FIG-114.



11TH OPERATION

FIG-115.

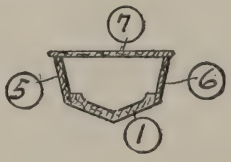


FIG - 116.
12TH OPERATION

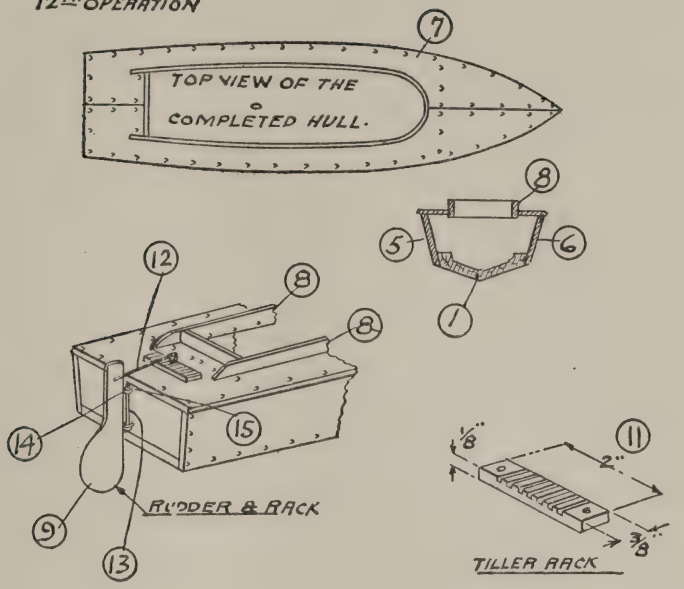


FIG - 117.

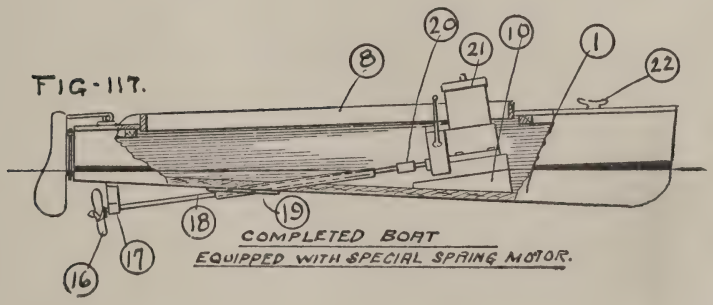
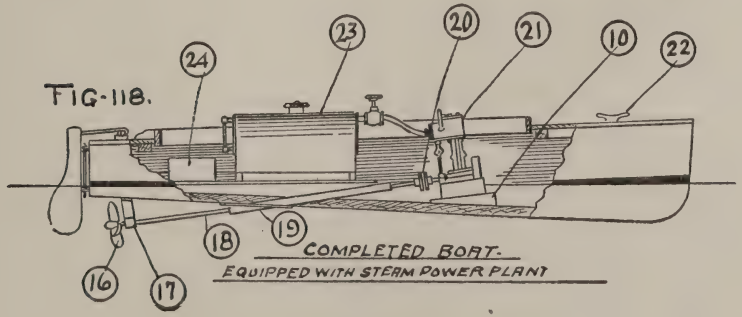


FIG - 118.



shown. The cost of the spring motor is much less, of course, and installation is considerably simpler.

The steam equipment will drive the boat about $5\frac{1}{2}$ miles an hour. The general chapters contain information on painting and finishing, gluing, bradding, soldering and every general point which should be known to do the job properly.

You will note in this boat, which is longer than the twenty-four-inch craft, that the shaft tube, piece 19, is different. It has a palm which comes fastened to the tube for securing it to the bottom of the boat, in order to steady the shaft better. The installation of this fitting is as follows: Push the inboard end into the shaft tube hole, previously bored on the proper angle, through the bottom of the boat. Then place some thick paint, or white-lead in oil, on the faying surface of the palm before it is pushed up against the bottom of the boat and made fast with four small brass countersunk head screws. Be sure that the tube is exactly parallel with the fore and aft center line of the boat as viewed from the bottom up. The white-lead helps to make the joint between the boat and the metal palm water-tight.

The operation of construction 1 to 12 inclusive are similar to operations 1 to 12 for the twenty-four-inch boat. The corresponding figures 105 to 118 inclusive, are necesarily different for consecutive numbering.

CHAPTER XIII

TWENTY-FOUR-INCH POWER BOAT
(Semi-Blocked Type)

This chapter deals with the construction of a twenty-four-inch power boat of the semi-block type to be powered with a special spring motor which looks like a gasoline engine and which will run for about five minutes, driving the boat about three miles an hour. This spring motor is equipped with starting and stopping clutch lever. It is an ideal and cheap boat and outfit for the younger builders, yet it has all the class and grace of the family power boat of from fifteen to twenty feet in length. It is light and sturdy.

Arrangements have been made with the firms listed to supply the special spring motor and metal fittings complete and all of the partly finished wooden parts for those desiring them. The completely dimensioned progressive pictures, however, will enable those desiring to do so to make all of the wooden parts themselves.

The partly finished material referred to is accurately cut by machinery and the specifications of the wood call for the finest pattern-makers' kiln-dried material. The parts may be obtained partly finished as follows:

Piece 1—Bottom block, shaped in plan view and elevation as indicated in the cut, operation No. 1, Fig. 119.

Piece 2—Stem piece, cut to proper length and end bevelled, bored with a $\frac{1}{4}$ in. dowel hole. Fig. 125.

Piece 3—Dowel turned to proper diameter and with sufficient material to cut from.

Piece 4—Stern piece or transom, material to cut from.

Pieces 5 and 6—Sides, steam bent to shape and partly fabricated.

Piece 7—Deck, partly cut to shape.

Piece 8—Coaming, steam bent to shape, ready to finish.

Piece 9—Rudder, material to cut from.

Piece 10—Motor base-blocks, material to cut from.

Piece 11—Tiller rack, material to cut from.

Parts 13, 14, 15, 16, 17, 18, 19, 20, 21, 22 may be purchased complete if desired. All other parts except the motor, piece 21, and propeller, piece 16, may be made, if desired, from dimensions given.

Those desiring to make parts 1 to 11, inclusive, from the rough material will find full dimensions on the drawings of these parts.

It is well, at this point, to read all the general chapters as a great deal of necessary information will be found there.

Operation One—Fig. 119: Lay out the bottom block, piece No. 1. Mark the position lines from the moulds by the dimensions given. Mark the fore and aft center line on both top and bottom of the block. The position lines for moulds must be at right angles to the fore and aft center line. Scribe a line $\frac{3}{8}$ in. down from the top edge of the block on both sides as shown. Lay out a line on top of the block for the cut-out for the motor.

FIG-119.
1ST OPERATION.

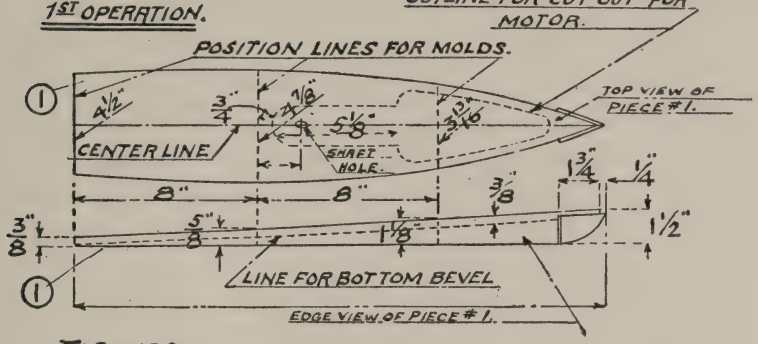
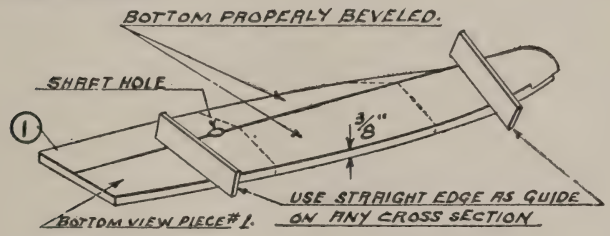
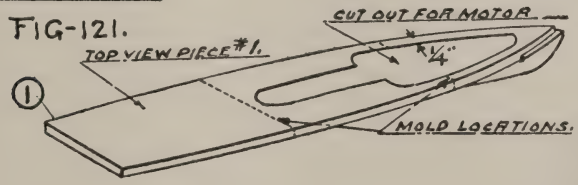

OUTLINE FOR CUT OUT FOR MOTOR.
POSITION LINES FOR MOLDS.
TOP VIEW OF PIECE #1.
CENTER LINE.
SHAFT HOLE.
LINE FOR BOTTOM BEVEL
EDGE VIEW OF PIECE #1.

FIG-120.
2ND OPERATION.



3RD OPERATION.

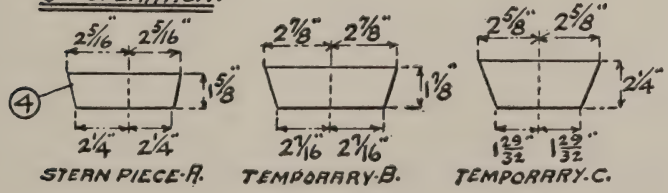
FIG-121.



4TH OPERATION.

FIG-122.

FIG-123.
5TH OPERATION.



Operation Two—Fig. 120: Bevel the underside of the bottom block, piece No. 1, from the center line to the scribed lines on the sides of the block as indicated, using a straightedge as a guide in any cross section. See cut. Do the cutting with a small plane. Be careful not to cut away either center line or scribed lines.

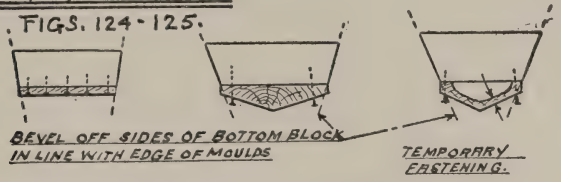
Operation Three—Fig. 121: Carve cut out for the motor on top of the bottom block to the line previously marked. Leave a wall $\frac{1}{4}$ in. thick all the way around. This may be done with a gouge, but be careful not to cut the walls thinner than $\frac{1}{4}$ in.

Operation Four—Fig. 122: Set stem piece, No. 2, in place, and continue the hole into the bottom block, but not all the way through. Secure the stem piece, No. 2, in place with the dowel and glue it. Drive in one small brad, as shown, to hold it until the glue sets. Use waterproof glue only.

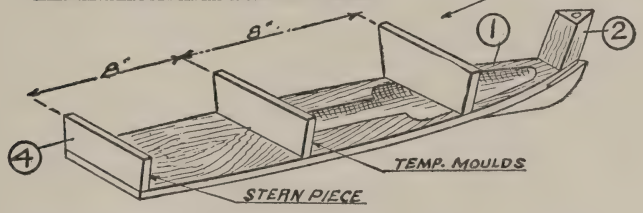
Operation Five—Fig. 123: Make stern piece, No. 4 (transom), of $\frac{3}{16}$ in. thick mahogany to the dimensions specified under this operation. Also make the two temporary moulds, using any handy material for them. Be careful to lay these pieces out accurately to the dimensions as given. First lay out a vertical center line on each mould, then draw a fine, sharp line exactly at right angles to it; the latter line in each case will be the top of the mould. Then measure down the depth shown for the bottom. Have the top and bottom lines of the moulds parallel to each other and exactly at right angles to the vertical center line. Then lay off the half-breadth of each at the top and bottom and connect the points carefully with a fine, sharp line. Saw them out and plane or sandpaper

6TH AND 7TH OPERATIONS

FIGS. 124 - 125.

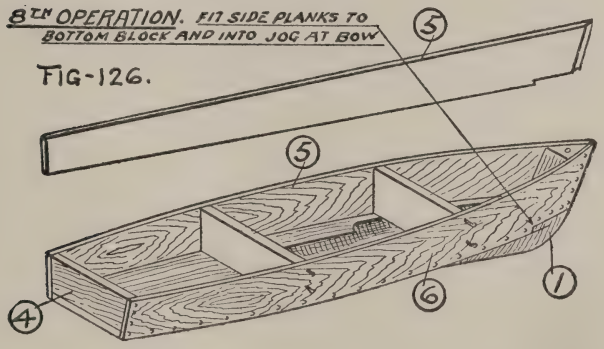


VIEW OF COMPLETED BOTTOM BLOCK WITH STERN PIECE AND TEMPORARY MOULDS IN PLACE.

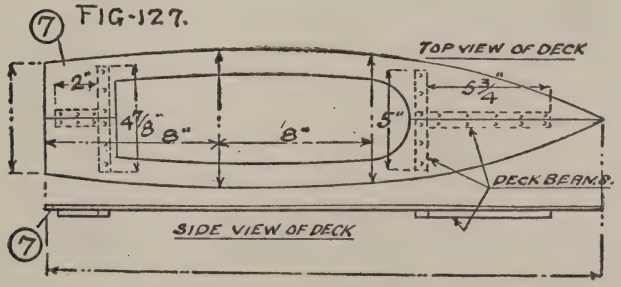


8TH OPERATION. FIT SIDE PLANKS TO BOTTOM BLOCK AND INTO JOG AT BOW

FIG-126.



9TH OPERATION.



exactly to the line. Be accurate in laying these moulds out because the proper shape of the boat depends upon them. One-half-inch thick material will be best for these temporary moulds.

Operations Six and Seven—Figs. 124 and 125: Fit the stern piece (transom) and the temporary moulds in their proper places with each vertical center line of the moulds exactly matching up with the fore and aft center line of the bottom block, and exactly over the transverse station lines on the block. If they fit, glue and brad the transom piece, using waterproof glue, as shown in operations 6 and 7. The other two moulds are only temporary and two brads driven part way in each as shown will hold. These brads will afterwards be pulled out and the holes plugged with a match stem cut to size and glued in place when the sides are fitted and the moulds removed. Bevel off the sides of the bottom block as shown, in line with the sides of the stern piece, and the temporary moulds.

Operation Eight—Fig. 126: Carefully fit the sides, pieces 5 and 6, to the bottom block into the jog at the bow, the stern piece, along the edge of the bottom block and at the stem. Press the sides firmly into place and make sure that they lie perfectly flat and fair and that the faying surface is perfect, otherwise the boat will leak. Trim carefully. Leave the side planks a little long at each end and a little wide at the top and bottom, as this will be planed off later when the glue is hard. If the fit is perfect, glue and brad them in place. Fit and secure one side at a time and let the glue harden over night. Then trim at the bow so that the other side plank can lap and lie flat

over the stem piece. After the glue is hard, trim aft to suit the stern piece and forward to suit the stem. Do the same thing at the bottom to suit the bevel of the bottom block. Then trim the top flush with the top of the stem piece, temporary moulds and stern piece. Drive a pair of brads, as shown, part way into the temporary moulds through the sides, but remove these and plug the holes when the moulds are removed.

Operation Nine—Fig. 127: Glue the halves of the deck together and fasten the beams and seam strips with glue and brads as shown. This deck may be given a slight crown if desired.

Operation Ten—Fig. 128: Remove the temporary moulds and glue and brad the deck in place. Trim off the superfluous material which extends beyond the sides more than $\frac{1}{8}$ in. This $\frac{1}{8}$ in. excess should be left to represent the half-round moulding.

Operation Eleven—Fig. 129: Fit the coamings and fasten them in place with glue and brads. Slightly countersink all brads and sandpaper and finish them smooth.

Operation Twelve—Fig. 130: Make and secure the rudder as shown, then make the tiller rack and secure it in place. Bend the tiller to fit in the rack and fit the tiller into the rudder exactly as shown. After the rudder is shaped and fitted it should be removed from the boat and finished (painted or varnished) separately. Fit the motor base blocks and then paint and finish the boat. Force the brass shaft tube, piece 19, into the slanting shaft hole through the bottom of the boat. Fit and secure the strut, piece 17. Fit the cleat, piece 22, and solder the propeller to the

10TH OPERATION

FIG-128.

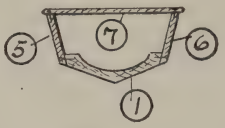
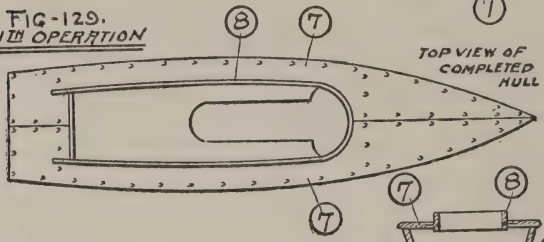
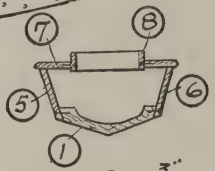


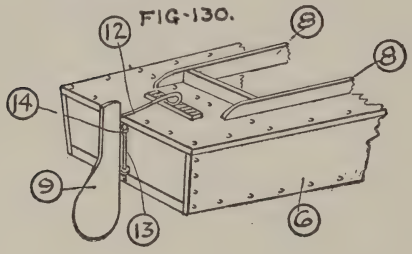
FIG-129.
11TH OPERATION

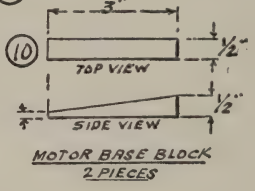




12TH OPERATION

FIG-130.





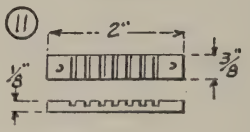


FIG-131.
~COMPLETED BOAT~
SHOWING INSTALLATION OF H.E.B. SPECIAL SPRING MOTOR.

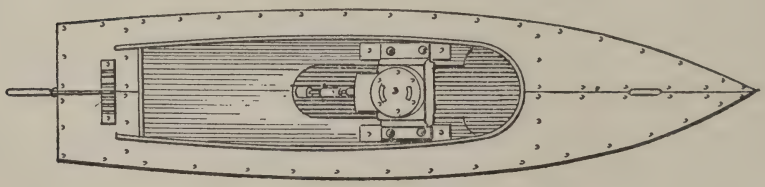
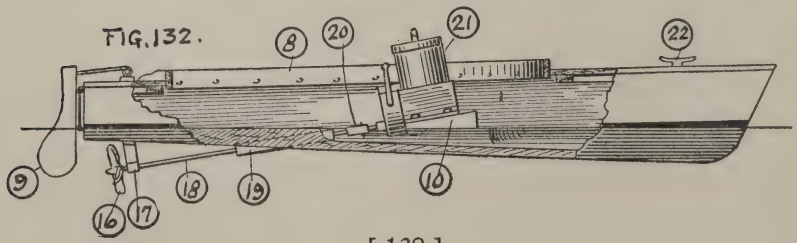


FIG.132.



shaft. Cut the shaft to its proper length to suit the motor, and the boat is then ready to run.

One more thing which is important. The shaft must be lined up perfectly because it has a bearing in the shaft strut, piece 17, and in the shaft tube, 19, and at the motor. If there is a bend in the shaft it will be hard to turn and much power will be lost. Be careful not to bend the shaft. First push the shaft tube into the hole in the bottom of the boat, it must fit snugly, and then insert the shaft and note if it turns perfectly free. It must turn just as freely when permanently fitted in the other bearings. In lining up the motor or engine on the bearers arrange it so that the shaft, when pushed up through the tube toward the motor, lines up perfectly with the connection on the power plant without forcing the shaft to right or left or up or down. Then mount the strut, piece 17, on the outboard portion of the shaft and slide it fore and aft until it touches the bottom of the boat the proper distance from the stern. Do not force the shaft to cause the least binding. The strut arms may be slightly bent apart or pushed together in order to make the strut shorter or longer as required. Press the palms of the strut firmly against the bottom of the boat before securing, and when you have found the proper place to secure it, press it in place firmly and rotate the shaft by hand, noting whether or not it is perfectly free. A slight shift must be made if there is any binding. Be sure to have the shaft directly under the fore and aft center-line of the boat. The propeller and rudder must both be located centrally when viewing the finished boat from aft.

Read the chapter on power plants for general hints relative to the installation and care of them.

The subject is covered in a comprehensive manner and the various forms of power plants suitable for all classes of model boats are considered. These include one-, two- and four-cylinder steam engines, also the boilers and gasoline burners and various small fittings and equipment needed as power plant auxiliaries to enable them to work efficiently.

CHAPTER XIV

FORTY-INCH FRAMED AND PLANKED POWER BOAT

The forty-inch framed and planked power boat is the most advanced type of construction undertaken in this book. Lovers of boats may have all the thrill of building a large boat without the cost as the method is exactly the same.

This boat will take any of the power plants mentioned and may be finished in almost any type of large boat. Several suggestions are shown in the illustrations, Figs. 133 to 138 inclusive.

Arrangements have been made with the manufacturers and many of the parts for this hull may be purchased partly shaped. For instance, the oak frames, steam bent to shape, stern and transom partly shaped, etc.

For those desiring to do the entire job themselves there are ample dimensions and cuts to work from. See the chapters on model making, painting, finishing, etc., for information in connection with steam bending and all the other operations not specifically mentioned in this description.

Operation One—Fig. 139: Chamfer the upper edge of the keel at one end as shown.

Operation Two—Fig. 140: Fasten the stern and deadwood to the keel with brads. Mark the frame stations on the keel.

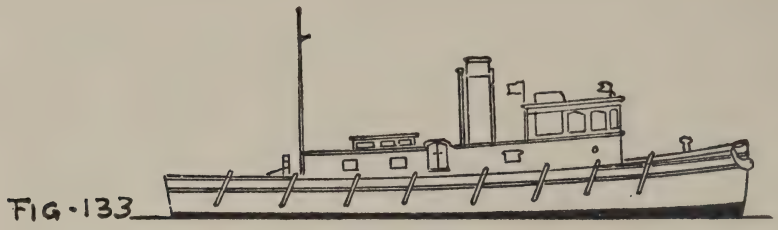


FIG-133

TUG BOAT

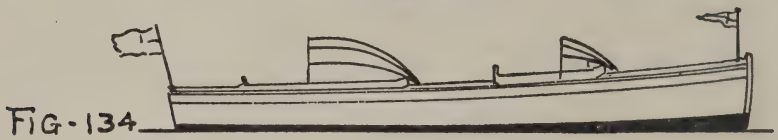


FIG-134

YACHTS LAUNCH

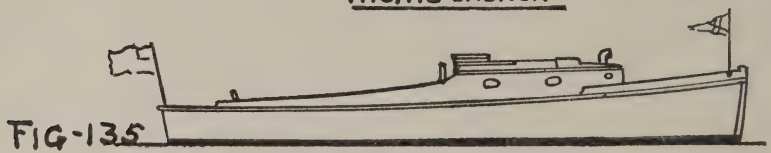


FIG-135

HUNTING CABIN CRUISER

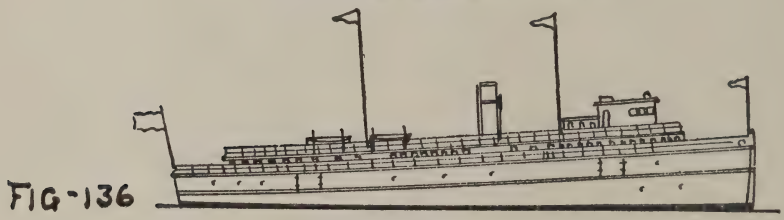


FIG-136

COASTWISE STEAMER

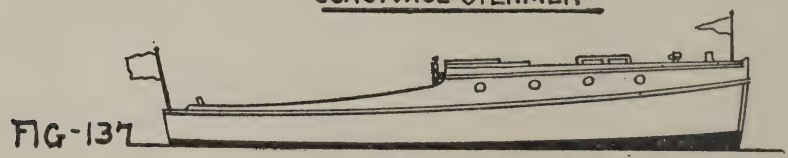


FIG-137

RAISED DECK CRUISER

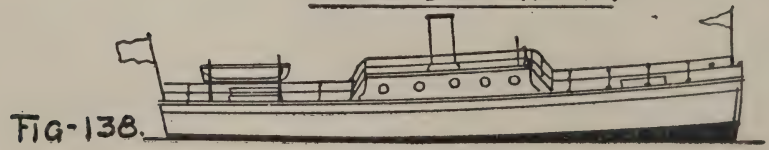
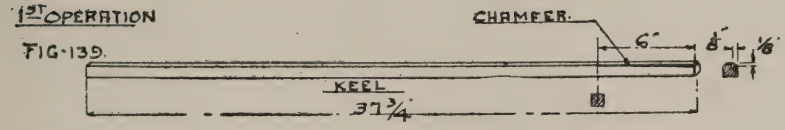
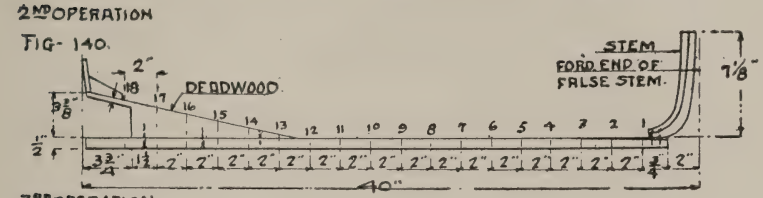


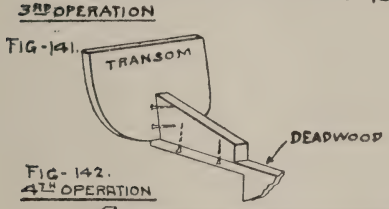
FIG-138.

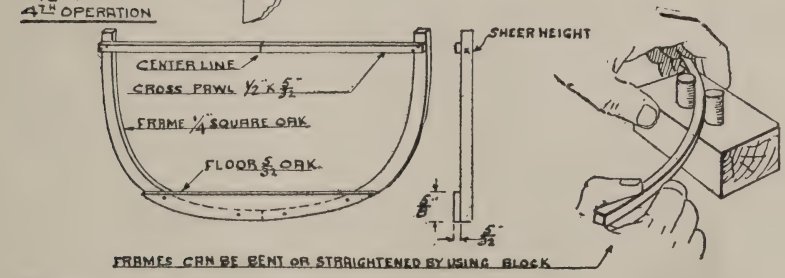
STEAM YACHT

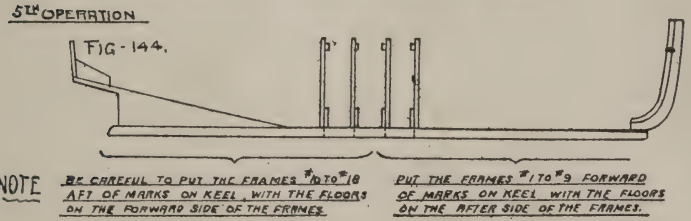
FRAMED AND PLANKED POWER BOAT





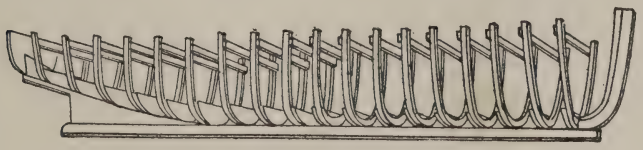






NOTE BE CAREFUL TO PUT THE FRAMES #10 TO #18 AFT OF MARKS ON KEEL WITH THE FLOORS ON THE FORWARD SIDE OF THE FRAMES.

PUT THE FRAMES #1 TO #9 FORWARD OF MARKS ON KEEL WITH THE FLOORS ON THE AFTER SIDE OF THE FRAMES.



Operation Three—Fig. 141: Fasten the transom to the after end of the deadwood by the small knee block which is cut to the proper angle to give the transom a slight inclination aft at the top.

Operation Four—Fig. 142: You have either bent your frames to the proper shape shown by the full-sized sections, Fig. 143 (Plate 3),* or else you have purchased them already bent.

Put the frames together in pairs so that they fit perfectly to the shape shown. They should be held to shape by temporary cross pawls or braces across the top and permanent floors at the bottom. Mark the center line on the cross pawls and on the floors and the sheer height on top of the frames as given in the full-size sections.

Operation Five—Fig. 144: Set each frame up at its proper place along the keel by driving a wire brad through the center of the floor board and into the keel.

Operation Six—Fig. 145: Fasten a wide strip of wood, about one inch wide, from the stern to the transom over the top of cross pawls so that the center marks are all in a straight line from end to end and all evenly spaced and plumb.

Operation Seven—Fig. 146: Shape two planks, one for each side at the top, their upper edges to be a straight line and their lower edges shaped as shown. Bevel off the edges of the transom and stern so that the plank will fit fair against them. Then fasten these two upper planks to the frames with wire brads, keeping the upper edges true to the sheer marks on the frames.

* Folding plate in pocket.

FIG. 145.
6TH OPERATION

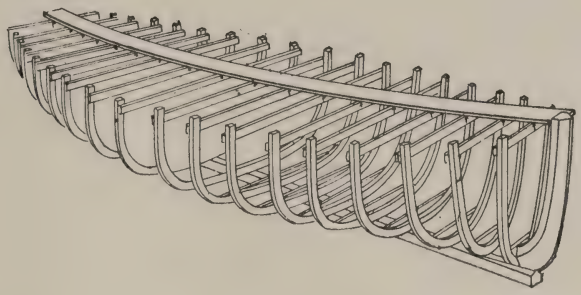
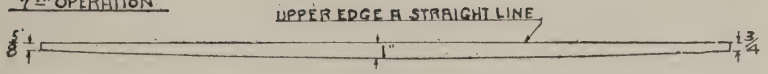


FIG. 146
7TH OPERATION



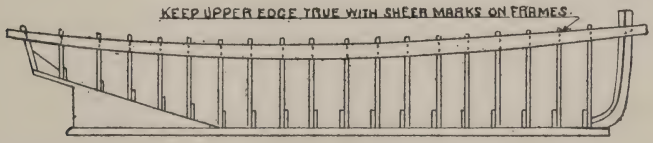


FIG. 147.
8TH OPERATION

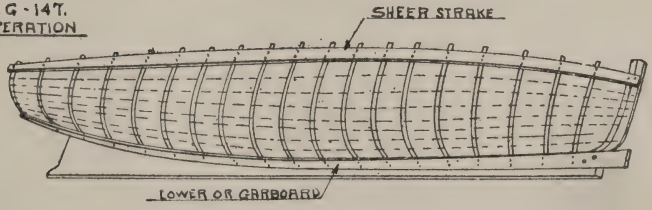
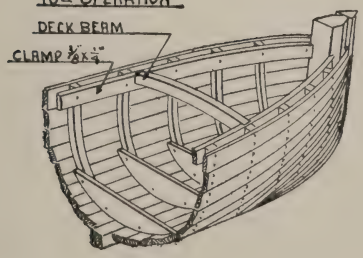
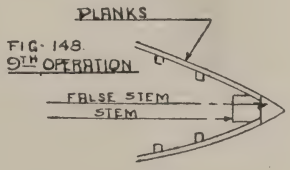


FIG. 149.
10TH OPERATION





Operation Eight—Fig. 147: Fit the lower edge of the garboard, this is the lowest strake of planking nearest to the keel, leaving the upper edge straight. Then fit the second plank to the edge of the first. Taper the second strake so that it is narrowest at the ends. If this is not done the planks will fill up at the ends and there will be an unplanked space near the middle. Taper each plank at the ends. There should be ten planks on each side. If you will divide each full-size template of the frames, Fig. 142, along the edge, into ten equal spaces, you will find the spaces at the middle frames will be wider than at the ends, because the expanded length of these frames is longer than the ones nearer the ends. By dividing the frames, the width of the planks at each frame may be ascertained.

Operation Nine—Fig. 148: Trim off the extra length of planks forward flush with the forward edge of stern and then secure the false stern with wire brads.

Operation Ten—Fig. 149: Remove the temporary cross pawls and trim the frames at their upper ends to the sheer line and then fasten the clamps in place with wire brads. Fit and fasten also about three deck beams, located to suit the type of boat you elect to build.

Operation Eleven: Finish the hull smooth with sandpaper after slightly countersinking the brad heads and if there are small cracks here and there where the seams of the planks do not butt together tightly apply some shellac with a brush or a match stem and then, while the shellac is still wet, sandpaper in the vicinity and the wooddust will mix with

the shellac and fill up the seam so that it will be watertight when painted and finished.

Where the seam is too wide to be effectively closed by this method, there is a preparation known as Plastic Wood, which is a form of wood fiber bearing putty which hardens in a short time so it becomes like wood and can be finished by the same methods.

Of course, workmanship that would leave gaps or seams of any moment is a mark of a slipshod mechanic and the model builder who is proud of his handicraft will match the joints accurately.

CHAPTER XV

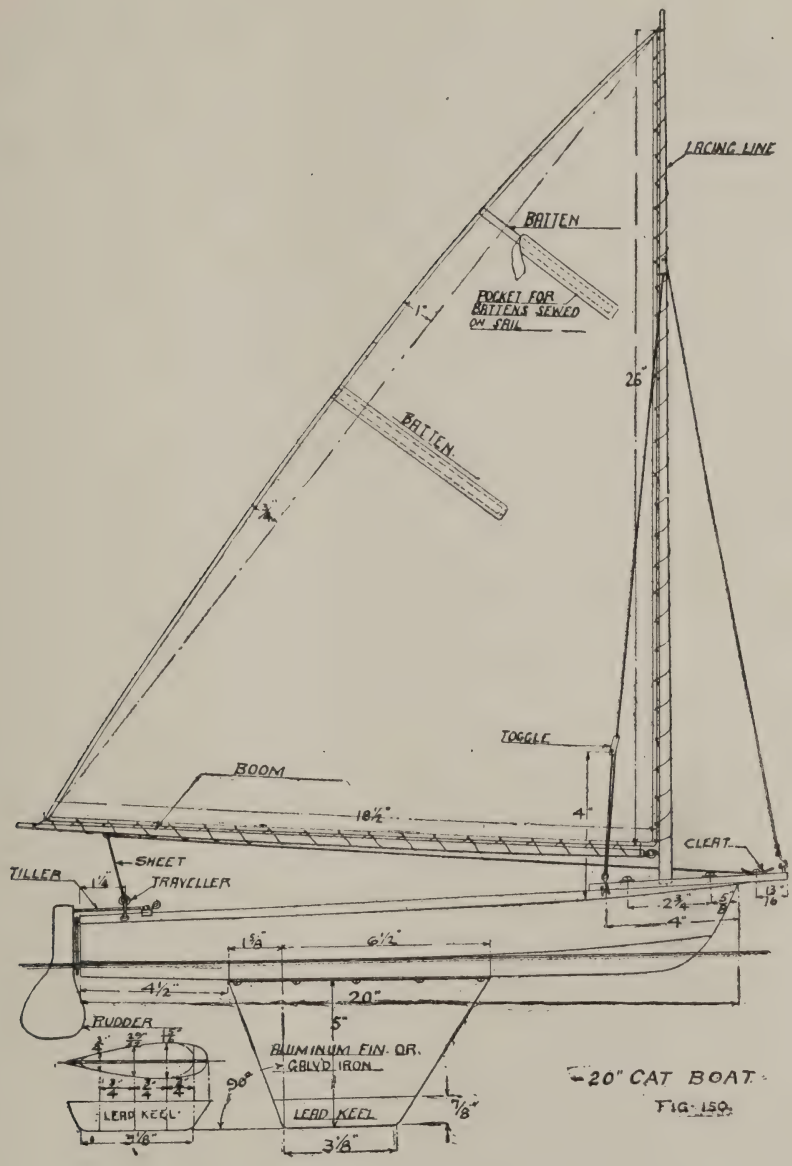
TWENTY-INCH V-TYPE CAT BOAT

This boat, Fig. 150, is typical of the famous v-type cat boats. The construction is simple and extremely light and the designer has made use of the semi-block form of construction. The hull is entirely of wood, built up exactly like a large boat.

The form lends itself to seaworthiness and makes the boat extremely stiff in a strong breeze. This boat is designed to make use of a patented sail shifting device which enables the amateur skipper to shift the fore and aft position of his sails. This is a desirable feature as it gives the boat a great advantage over another boat with which it may be racing and which is not so equipped. This feature and its advantages have been described in the general chapters of this book. Before proceeding with the construction of this boat it is a good plan to read all of the general chapters as they treat in detail upon each and every feature of the construction. Your boat will not be as successful if you omit reading these chapters.

Sailing, after all, is where the real skill of boating comes in and as much can be learned from these little boats as in actually sailing the larger boats.

The bottom block, piece 1, Fig. 151, should be of pattern-makers' white-pine, kiln-dried. The stem piece, piece 2, Fig. 155, should be of the same material,



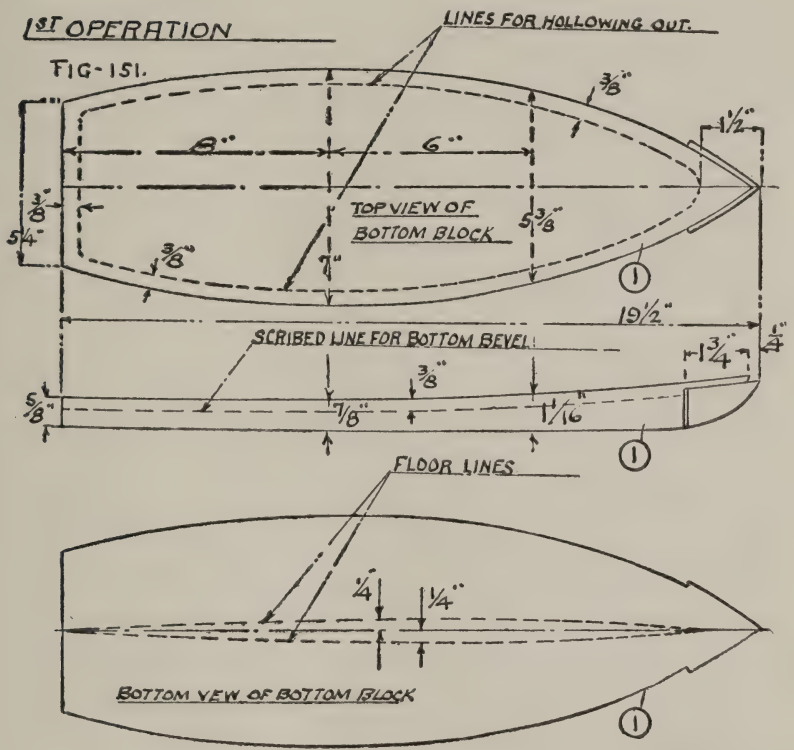
20" CAT BOAT.
FIG. 150.

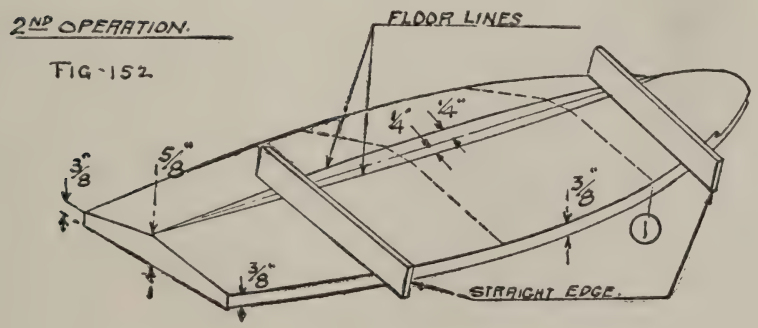
as is the stern, piece 4, also. The temporary moulds may be of any material, preferably some soft wood. The side, pieces 5 and 6, Fig. 158, may be either of thin white-pine or cedar of the best quality, kiln-dried. They may also be of three-ply birch veneer made up with waterproof glue. The deck, piece 7, Fig. 160, may be of the same material as the sides. The deck beams, 8, are of white-pine and the mast, spars, bowsprit (mast-step), spruce. The rudder and tiller rack are of mahogany. The fin may be of aluminum, brass, or galvanized iron, but the weight at the bottom of this should be of lead.

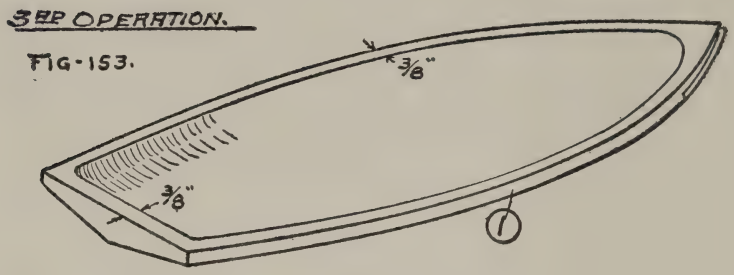
Arrangements have been made with firms to supply the parts either partly or completely finished, ready to assemble, for anyone desiring to procure them. The materials may be also purchased in the rough from any lumber dealer and the builder may shape them himself from the dimensions as given in the drawings.

Operation One—Fig. 151: Lay out the bottom block and scribe a line $\frac{3}{8}$ in. from the edge all the way around. Mark the position lines of the moulds on the top-side of the bottom block, piece 1. Shape the bottom block to the dimensions given on the three views of this first operation. On the side edges of the block scribe a line $\frac{3}{8}$ in. down from the top edge on each side. Draw in a fore and aft center-line on both the top and bottom of the block and, in addition, on the bottom surface, draw in the floor lines $\frac{1}{4}$ in. each side of the center-line. This leaves a flat surface on which to fasten the fin keel.

Operation Two—Fig. 152: Bevel the underside of the bottom block from floor lines to the scribed lines


1ST OPERATION
FIG-151.
LINES FOR HOLLOWING OUT.
8"
6"
3/8"
1 1/2"
3/8"
5 1/4"
TOP VIEW OF BOTTOM BLOCK
5 3/8"
7"
3/8"
1
19 1/2"
SCRIBED LINE FOR BOTTOM BEVEL
1 3/4"
1/4"
3/8"
5/8"
7/8"
1 1/16"
1
FLOOR LINES
1/4"
1/4"
BOTTOM VIEW OF BOTTOM BLOCK
1


2ND OPERATION.
FIG-152.
FLOOR LINES
1/4"
1/4"
3/8"
5/8"
3/8"
3/8"
1
3/8"
STRAIGHT EDGE.


3RD OPERATION.
FIG-153.
3/8"
3/8"
1

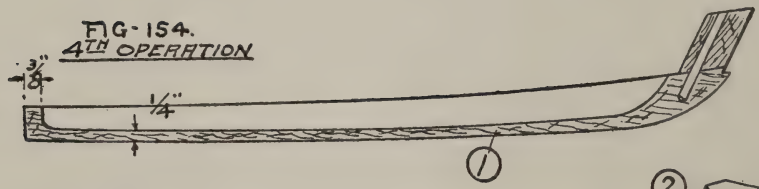


FIG-154.
4TH OPERATION
3/8"
1/4"
1

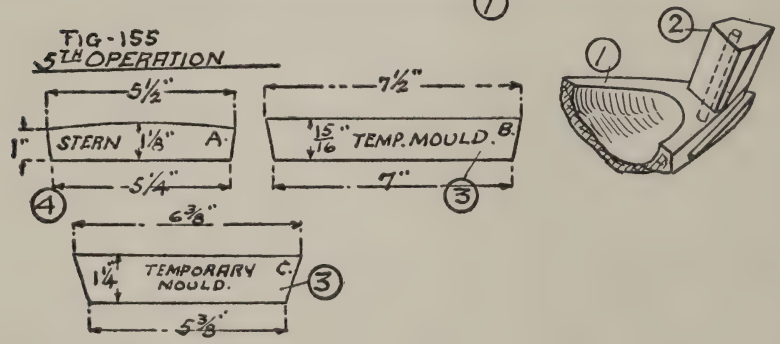


FIG-155
5TH OPERATION
5½"
STERN
1⅛"
A.
1"
5¼"
4
7½"
15/16" TEMP. MOULD.
B.
7"
3
6⅜"
1¼"
TEMPORARY MOULD.
C.
3
5⅜"
1
2
A

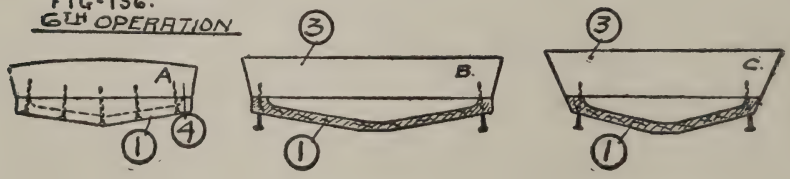


FIG-156.
6TH OPERATION
A
1
4
3
B.
1
3
C.
1

on the sides. Use a straightedge as a guide on any cross section. If you make the bottom block yourself, be careful to cut the landing forward, to receive the notched out side planks. This work must be done carefully and accurately as the water tightness of the boat depends largely upon this feature. Have the sides true, to insure a good tight faying surface between the sides and the bottom.

Operation Three—Fig. 153: Carve out the upper surface of the bottom block to the lines scribed $\frac{3}{8}$ in. from the edge. Carve the bottom block to about a $\frac{1}{4}$ in. wall thickness all over except the outer edge and stern. This work may be accomplished best with a gouge.

Operation Four—Fig. 154: Make the stem piece as shown and secure it in place with waterproof glue and a dowel.

Operation Five—Fig. 155: Make the stern piece and temporary moulds B and C to the dimensions given under that operation.

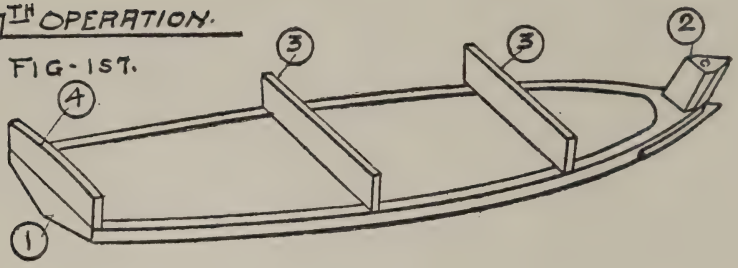
Operation Six—Fig. 156: Fasten the stern piece and temporary moulds in place. Note that the stern piece is secured permanently with brads and glue while the temporary moulds B and C are bradded only.

Operation Seven—Fig. 157: Bevel off the sides of the bottom block in line with the sides of the stern piece and temporary moulds.

Operation Eight—Fig. 158: Shape the sides, pieces 5 and 6, as indicated and steam bend them to suit the form of the boat. See the general chapter on model making for steam bending. Fit the sides carefully in place, making sure that the faying surfaces are per-

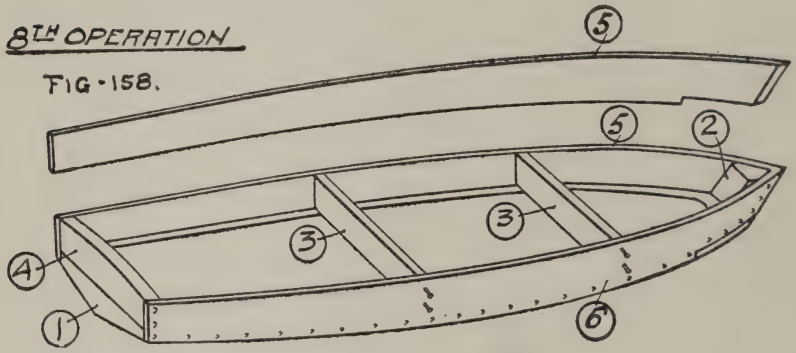
7TH OPERATION.

FIG-157.



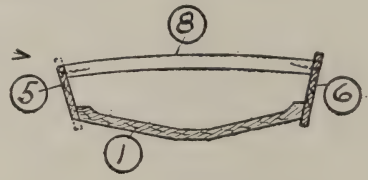
8TH OPERATION

FIG-158.



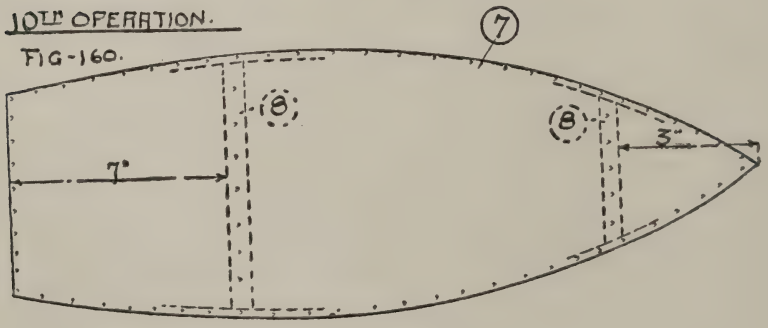
9TH OPERATION

FIG-159.



10TH OPERATION.

FIG-160.



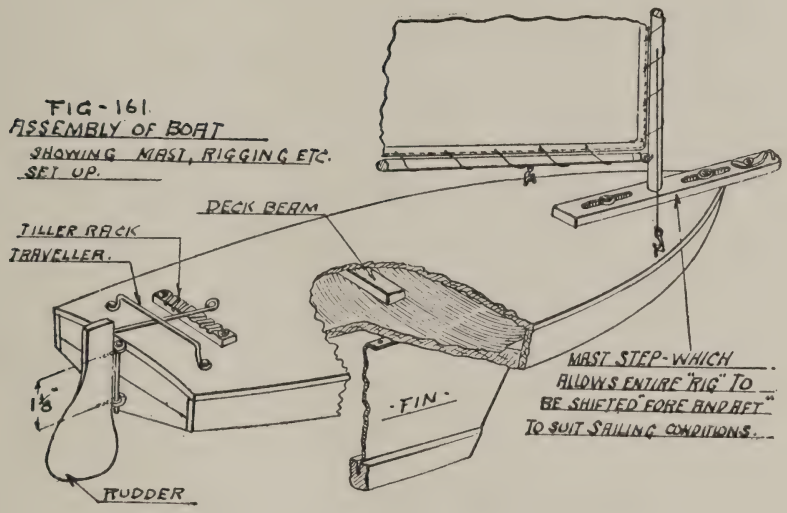
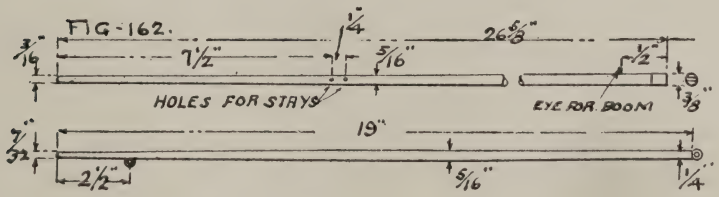
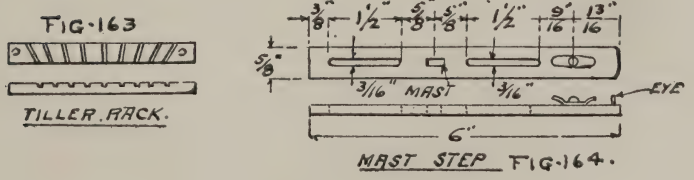


FIG-161.
ASSEMBLY OF BOAT
SHOWING MAST, RIGGING ETC.
SET UP.





fect, then glue and brad them permanently. The temporary brads in the moulds are not driven all the way in and are later removed, the holes being plugged with a match stem and glued.

Operation Nine—Fig. 159: Make the deck-beams to the same crown as the stern piece and secure them in place with one brad each. Remove the temporary moulds and place the upper edge of the side planks to line up with the deck-beams. Bevel the lower edge of the side planks to conform to the bottom bevel.

Operation Ten—Fig. 160: Fasten the deck in place and smooth off the edges. Fasten the fin in place with small brass screws as shown in Fig. 161. The spars, mast step, tiller, rack, rudder, etc., are made and installed as indicated in Figs. 162, 163 and 164.

The sails and rigging are as shown. See the general chapters for spar making, sail making, painting, sailing, etc.

CHAPTER XVI

TWENTY-EIGHT-INCH STAR CLASS

This Star class boat is the latest product of the Boucher shops and represents twenty-two years of study and experience in making marine models. It embodies absolute completeness and accuracy and yet is so simplified that an amateur can put it together and turn out a good job.

The completed model represents a faithful and properly proportioned reproduction of the famous international Star class racing yacht on a scale of $1\frac{1}{4}$ in. to one foot and will give you as big a thrill in racing against other Star class models as the owners get from racing the full-sized Star boats.

In order to obtain the best results the building instruction should be read over thoroughly before you commence any of the work.

If you carry out these instructions carefully, the result will be a perfect sailing model which you will be proud to race against other Star class models.

FIRST AND ALWAYS—DO NOT HURRY!

It takes time to do a good job.

Read carefully all the general chapters of the book before proceeding with this construction. Much necessary information is contained there which cannot be detailed here.

Arrangements have been made for those who so de-

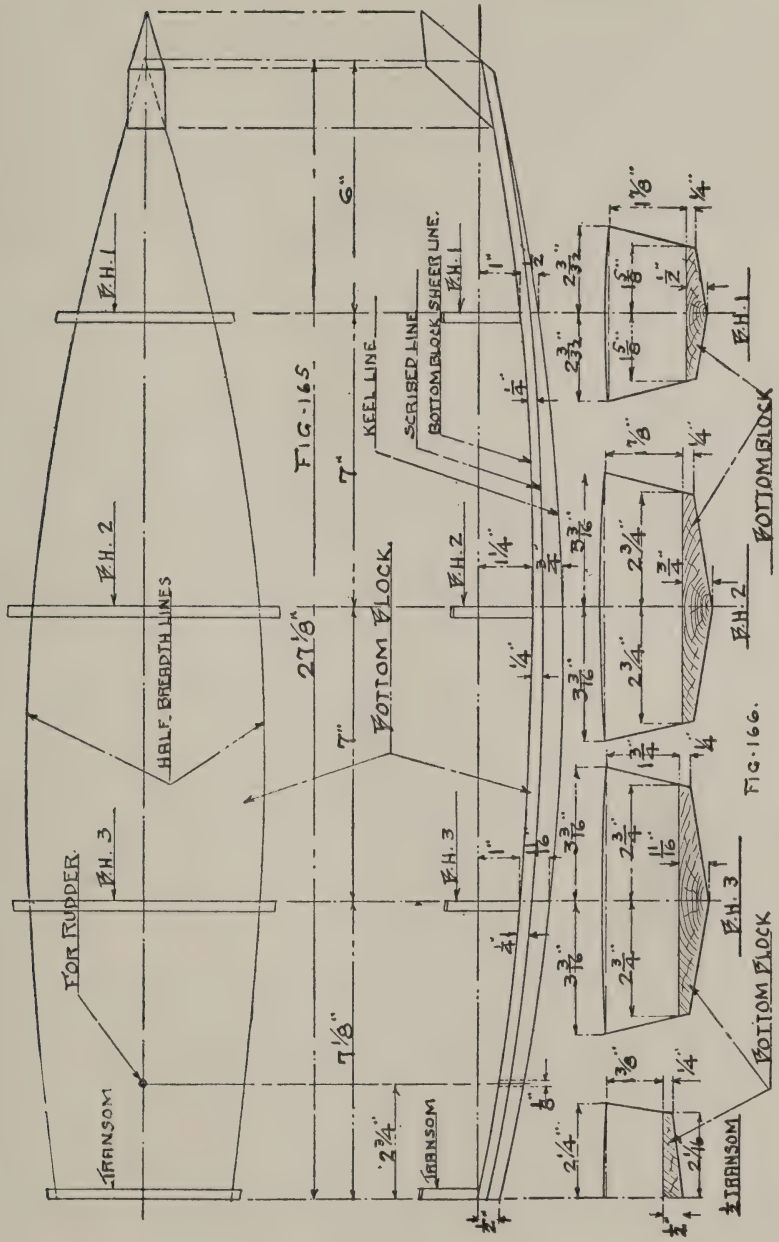
sire to purchase parts for this boat partly shaped and made from specially selected material, at about the same price which one would have to pay for the best grade of rough materials.

The partly finished parts will be supplied as follows. Bottom-block, shaped as indicated, Fig. 165. Transom and bulkhead, 1, 2, 3, cut to shape as shown in Fig. 166. Stem, piece 2, cut to shape as shown. Side planks, pieces 3 and 4, steam bent and partly shaped. Deck, material to cut from. Rudder, piece 5, shaped and secured to the rudder stock ready to install. Rudder tube, piece cut to length, threaded at one end. Spars rounded to their greatest diameter. Balloon sail cloth, rigging, fastenings, glue, etc.

Those desiring to make all the parts complete will find no difficulty in doing so as all the dimensions are clearly given.

The bottom-block, bulkheads, transom and sides are to be of pattern-makers' white-pine, kiln-dried. The deck is of three-ply birch veneer. The stem piece and bowsprit are of mahogany and the spars of spruce.

The bottom-block should be a straight pine board 30 in. long, 6 in. wide and 2 in. thick when dressed. Mark the sheer line and keel line on both fore and aft edges and cut neatly to the lines. Then mark the fore and aft center-line on both the top and bottom surfaces and also bulkhead station lines on the top and sides. Then lay out the half-breadth lines, all from the dimensions given, and saw out the shape of the bottom-block as in the plan view. Next scribe a line $\frac{1}{4}$ in. down from the top surface of the block on both sides and stern. Bevel the block from the scribed


F.H. 1
F.H. 2
F.H. 3
HALF BREADTH LINES
FOR RUDDER
TRANSOM
FIG·165.
KEEL LINE
SCRIBED LINE
BOTTOM BLOCK
SHEER LINE.
BOTTOM BLOCK.
27⅛"
7"
6"
7⅛"
2¾"
FIG·166.
BOTTOM BLOCK

lines on the sides to the fore and aft center-line on the bottom. Do not cut the lines away, but cut just to them.

The width of the bottom-block is the same dimension at the several bulkhead station lines, and the transom line as the bulkheads and the transom pieces are themselves at the bottom, and the height of the sides equal to a line measured from the scribed line on the bottom-block to the top of the particular bulkhead or transom at the sides, all made to the dimensions given. Leave a little extra material on the sides. This may be trimmed after fitting. The sides are $\frac{1}{8}$ in. thick pine, steam bent to the shape required. See the general chapters for the method of steam bending, etc.

We are now ready to start on the same footing with those who have purchased the partly shaped parts.

First Operation

Nail the stem to the bottom-block, being sure that the outside surfaces of the stem are flush with the edge of the bottom-block. Use $\frac{3}{4}$ in. brads. (Fig. 167.)

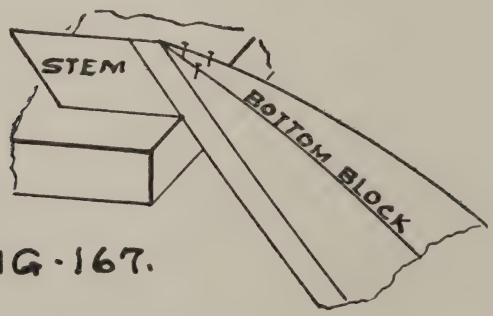


FIG. 167.

Second Operation

Fasten the bulkheads and transom to the bottom-block. Be sure that the bulkheads are properly Placed according to numbers and that the ends are flush or even with the edge of the bottom-block; if they are not exactly flush, use a plane. (Fig. 168.)

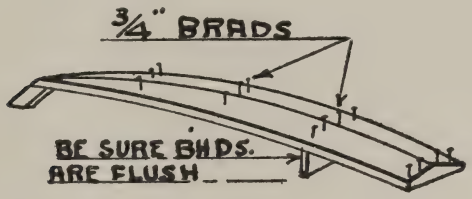


FIG-168.

Third Operation

Secure the side planks to the stem. Locate the side planks to the stem so that all the edges are fairly flush and put in screw A, which is ¾ in. long. (Fig. 169.)

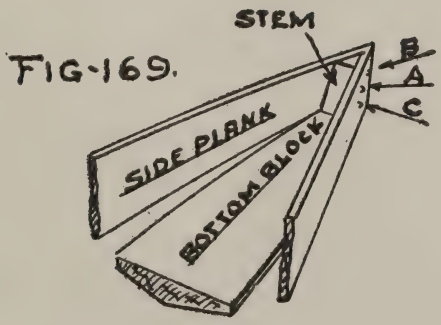
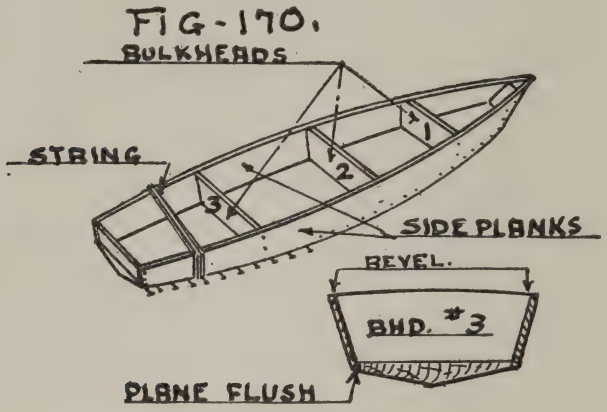


FIG-169.

Fourth Operation

Bend the planks in gradually toward the stern and if necessary swing the side planks around the screw A until edges of the planks are flush with the bottom of the bottom-block. Hold the side



planks and bottom-block together with string and then put in the other two screws through the side planks into the stem and then nail the planks into the bottom-block, commencing at the stem and working toward the stern. Use the $\frac{5}{8}$ in. brads about $\frac{1}{4}$ in. apart, also drive two or three brads through the planks into the bulkheads.

The string may now be removed from the stern so that all edges which do not come perfectly flush together may be smoothed down with a plane.

Now that the hull is completed, before putting on the deck, give the whole inside a coat of paint. Be sure to rub the paint thoroughly into all the seams in order to insure the hull being water-tight. This also preserves it.

The side planks, bulkheads, transom and stem should be planed evenly and flush. Put a slight bevel on top edges of planks in line with bulkheads. (Fig. 170.)

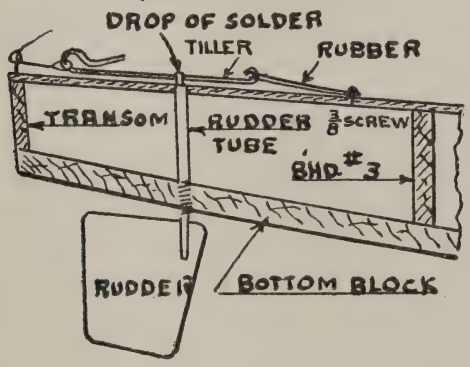
Fifth Operation

PUTTING ON THE DECK

In order to properly locate the deck, the rudder sleeve (the small brass tube) must first be screwed into the bottom-block from the inside and until the tube just projects through the bottom. (See illustration No. 6.) (Fig. 169.)

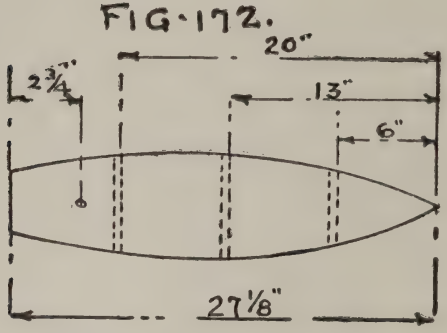
Now you can put paint on the upper edges of the side planks, transom and stem just before placing the deck, in order to insure its being watertight.

FIG. 171.



Place the deck on the hull with a hole in the deck directly over the rudder sleeve and the pointed end of the deck central with the stem. Drive the brads at stem and stern on the center line, (points A), then press the deck down to the hull (Fig. 171), amidships, and drive the $\frac{1}{2}$ in. brads

through the deck into the side planks, commencing amidships, (points B and C), alternately on each side and alternately towards each end, (points D, E, F, and G), about 1 in. apart. When all the brads have been put in, the edges of the deck may be made flush with the sides and stern with a plane. (Fig. 172.)



Sixth Operation

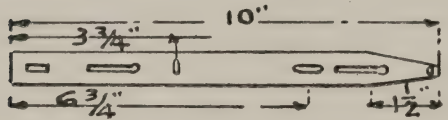
APPLYING FIN KEEL

The location for the fin keel is marked on the underside of the bottom-block. Secure it to the hull exactly on the center-ridge, with ¾ in. screws through the holes in the fin, into the bottom-block and with the projecting end of the bulb pointing aft. Be sure to drive the screws in as far as they will go.

The hull has now reached a stage where it is advisable to think of the final appearance. Go over all the brads and screws, driving both a little be-

low the surface and then plane and sandpaper the hull all over with No. 0 sandpaper. Apply a priming coat of paint, (any color), to the hull only, and allow it to dry thoroughly, then fill up the slight indentations with putty. The deck should be varnished, not painted.

FIG-173.
SAIL SHIFTING DEVICE



Seventh Operation

SPARS

Shape up the sail shifting device according to the sketch. (Fig. 173.)

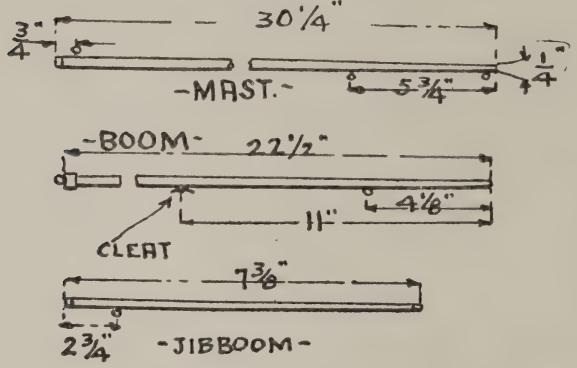
Shape up the mast and boom to conform with the dimensions on the sketch. In doing this hold the piece by the butt end and lay it on a table. Using the plane, start tapering on four sides. When this is done the spar will be square at the small end. Then make it eight-sided and then round, finally sandpapering it smooth. The sketch shows clearly the shape of the end of the mast which is to be set in the sail shifting device. Put on the screw eyes and ferrule as indicated on the sketch. (Fig. 174.)

Painting

Choose whatever colors you desire and apply three thin coats to the hull and keel. The best results

are obtained by using flat or Japan paint, allowing each coat to dry thoroughly and then rubbing it over lightly with fine sandpaper. After the last coat is thoroughly dry, varnish the whole hull, keel, spars and sail shifting device with two coats of spar varnish.

FIG-174.



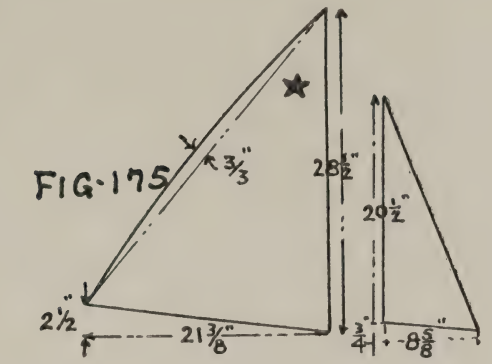
Eighth Operation

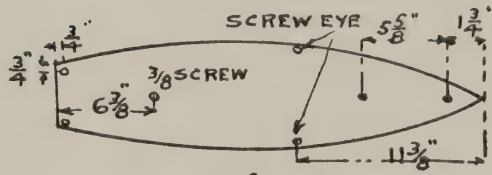
RUDDER

Put the rudder in place and put the tiller on with the hooked end towards the stern (see sketch No. 171.). The tiller should be fastened in the slot on the rudder post with a drop of solder. If you have no soldering facilities, any tinsmith or radio repairman can do it for you.

SAILS

Hem the sails so that they will, when finished, be according to the sketch. Cut out the printed stars and sew them opposite each other in the position indicated in the sketch of the sails. (Fig. 175.)





FIG·176.

POSITION OF DECK FITTINGS
(Fig. 176)

RIGGING PLAN

Sketch Showing Rigging in Detail
(Fig. 177)

SAILING

The patented sail shifting device permits you to shift both sails to suit the strength of the wind, thereby obtaining a balance of the sails to the hull and thereby keeping the model on its course. If it is blowing hard shift the device forward, if blowing light, the device aft. When sailing before the wind, let the sheet well out and hook

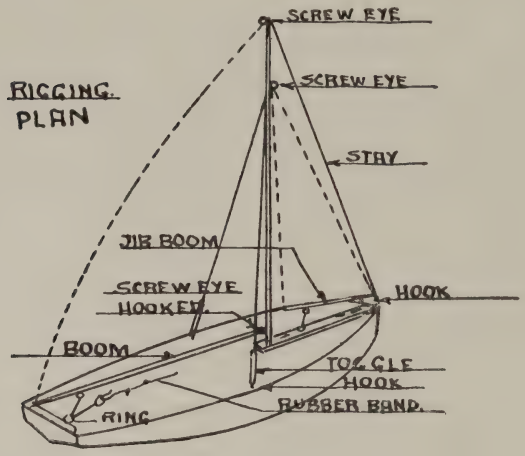


FIG. 177.

the ring over the after end of the tiller. The pull of the sheet will turn the rudder enough to keep the boat on its course. When sailing close hauled and the sails are properly balanced to the hull, the ring may be removed from the tiller. Sometimes better results are obtained by leaving the ring on the end of the sheet hooked on the tiller.

You have no doubt enjoyed building this scale model, but additional pleasure and excitement will come in racing it against competitors who have built the same boat.

CHAPTER XVII

THIRTY-INCH SLOOP, MARCONI RIGGED

The lines or form of this boat were designed by a well-known Naval Architect and were chosen, after many races between different models of the same size, as the fastest and best adapted for all around sailing and racing. It is also one of the best from the standpoint of construction.

The best results, however, cannot be obtained unless the hull is properly and carefully shaped with both sides absolutely alike, exactly to the form of the moulds, and dug out with care to an even thickness of one-quarter of an inch or less.

Arrangements have been made with this boat, similar to the other boats, by which those wishing to do so may purchase the parts, partly finished, at a price equal to what one would have to pay for the best pattern-makers' kiln-dried pine when bought in small quantities. The semi-finished parts come with the hull, roughed out and glued similar to the cuts, Figs. 180-181. The fin and lead bulb come properly shaped, ready to attach. Material for the deck, the spars, turned round to their greatest diameter, die-cut stiff paper templates for trimming the sides to the proper shape and fastenings and sail cloth are also supplied.

Figures 178 (Plate 4)* and 179 give dimensions in ample detail for those desiring to construct the entire

* Folding plate in pocket.

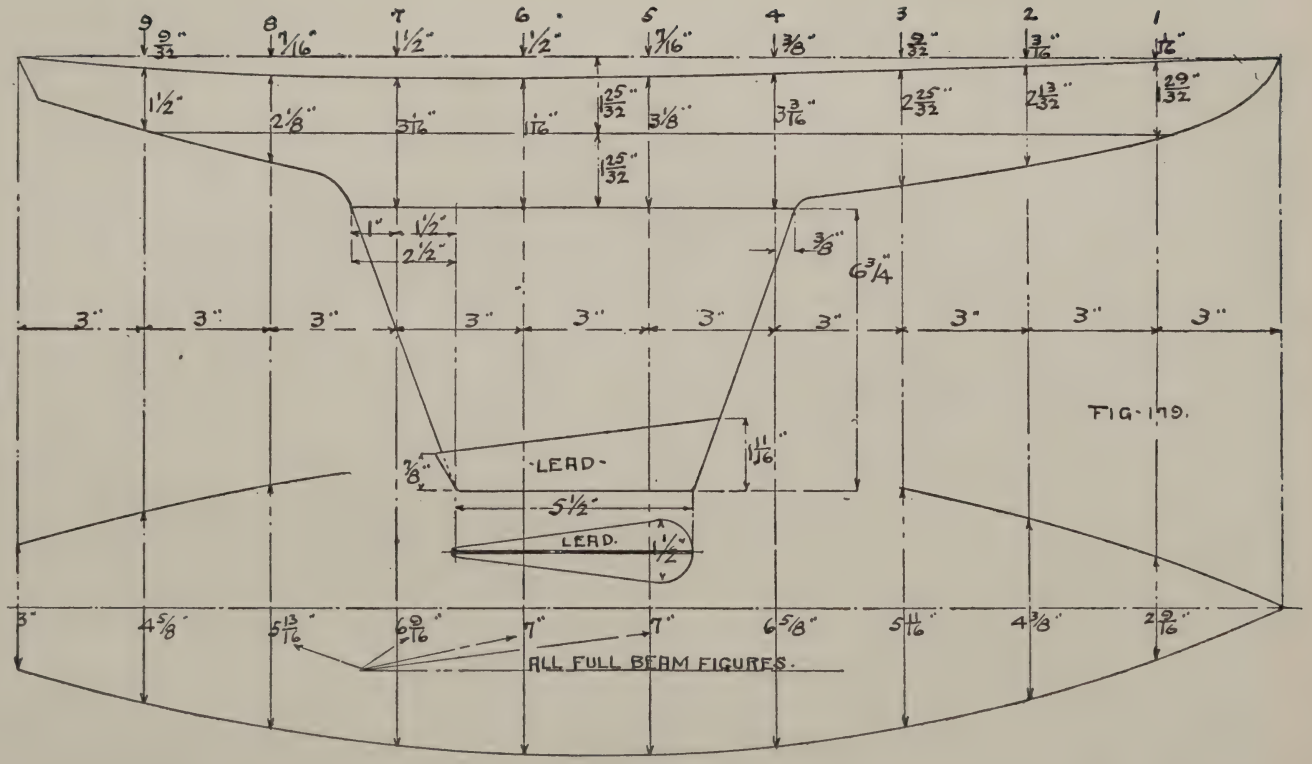
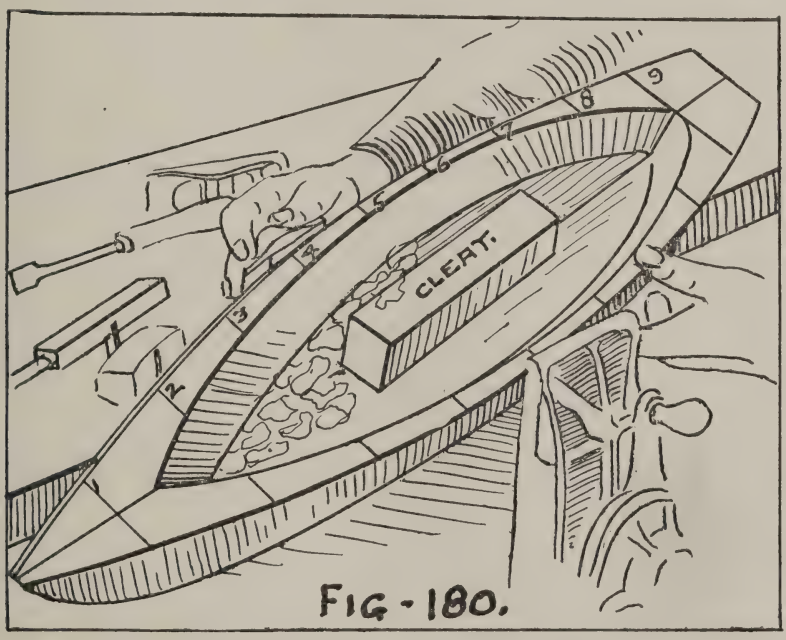

9
8
7
6
5
4
3
2
1
9/32"
7/16"
1/2"
1/2"
7/16"
3/8"
9/32"
3/16"
1/16"
1½"
2⅛"
3⅛"
1/16"
25/32"
3⅛"
3 3/16"
2 25/32"
2 13/32"
29/32"
25/32"
1"
1½"
2½"
3/8"
6¾"
3"
3"
3"
3"
3"
3"
3"
3"
3"
3"
LEAD.
1 11/16"
7/8"
5½"
LEAD.
1/2"
3"
4 5/8"
5 13/16"
6 9/16"
7"
7"
6 5/8"
5 11/16"
4 3/8"
2 9/16"
ALL FULL BEAM FIGURES.

FIG. 179.

boat themselves from unfinished material. The following preliminary work is necessary if these parts are to be made by the builder.

The boat is constructed in two lifts of the thickness shown. Secure two boards, pattern-makers' best kiln-dried pine, 31 in. long, $7\frac{1}{2}$ in. wide and $1\frac{7}{8}$ in. thick, dressed. Mark a fore and aft center-line on the top, bottom and ends of each board, also the transverse frame stations as indicated at three-inch cen-



ters. Mark the cut out for the top lift and saw it out with a compass saw. If the material is nicely dressed, next glue the top block to the bottom one with waterproof glue. Line up the center-lines and frame lines accurately on each block. Mark the profile of the boat, from the figures given, on both side faces of

the blocks and saw neatly to the lines. Mark the new frame or station lines on the top, the old ones having been cut away when the sheer line was cut. Lay out the half-breadths on the proper stations from the figures given and cut both sides accurately and neatly to the line. The model will now appear as in the figures shown in operations 1 and 2.

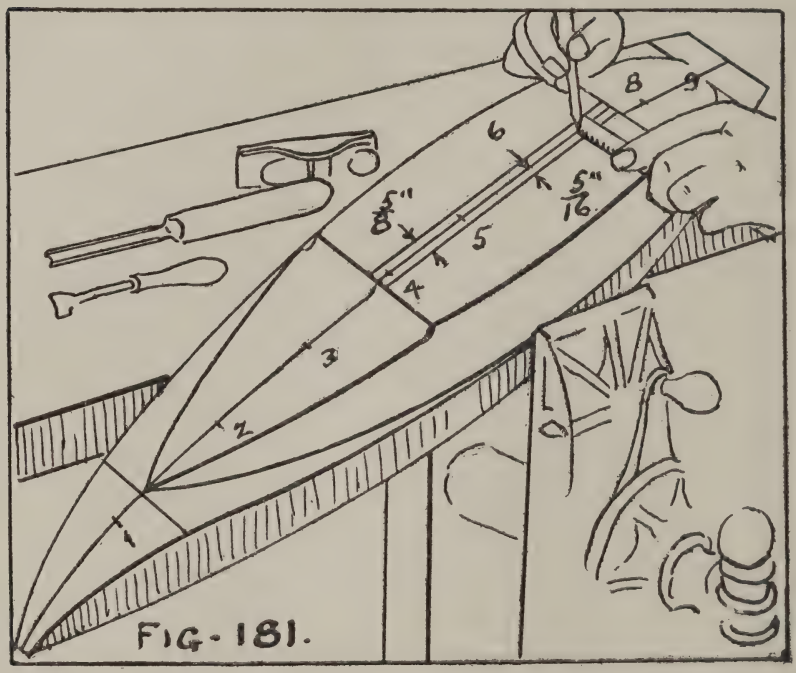


FIG-181.

We are now ready to start in on an equal footing with those who buy the semi-shaped parts.

Operation One—Fig. 180: BE CAREFUL!

Place the block model in a vise as shown in Fig. 180. Number the station marks on the block commencing forward 1, 2, 3, 4, etc., to correspond with the numbers on the paper templates or moulds. Smooth the sides of the block with a small plane to

the line drawn on the upper part of the block. This is the exact shape of the finished model at the deck. For convenience in handling the block for shaping the exterior of the hull, screw a cleat or block of wood, one inch square by six inches long on the bottom of the inside of the block.

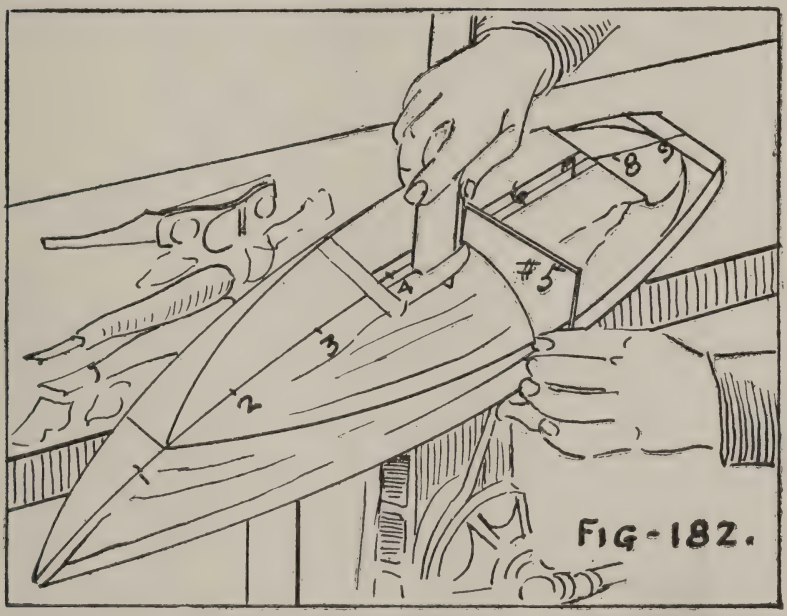


FIG-182.

Operation Two—Fig. 181: DO NOT HURRY! Turn the model upside down and screw it in the vise as shown in Fig. 181. First: smooth off the flat portion of the bottom of the block so that parallel lines may be drawn on each side of the center line, $\frac{5}{16}$ in. out from the center, making a total width of $\frac{5}{8}$ in. This space is to be left flat so that the angle pieces which will be attached to fin-keel may be secured. As an additional aid for locating the templates for shaping the outside of the hull, the stations, marked on

the deck are to be transferred to their proper positions to the bottom and side of the block and numbered as shown.

Operation Three—Fig. 182: The block is now ready for shaping the outside of the hull. A flat one-inch chisel or a chisel gouge can now be used to shape the exterior of the hull by gradually rounding off the sharp corners to fit to the templates. For instance, section 5 on the hull is to be cut down so that template 5 will fit fairly close, then sections 4, 2 and so

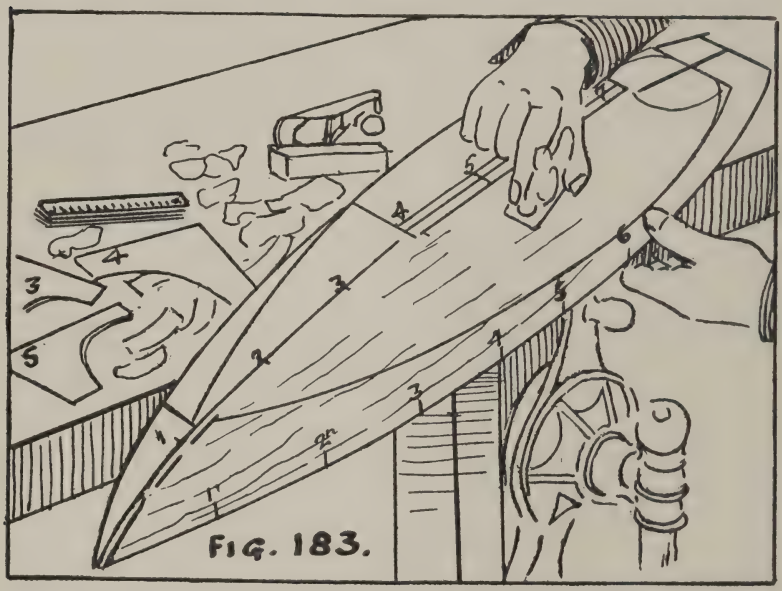


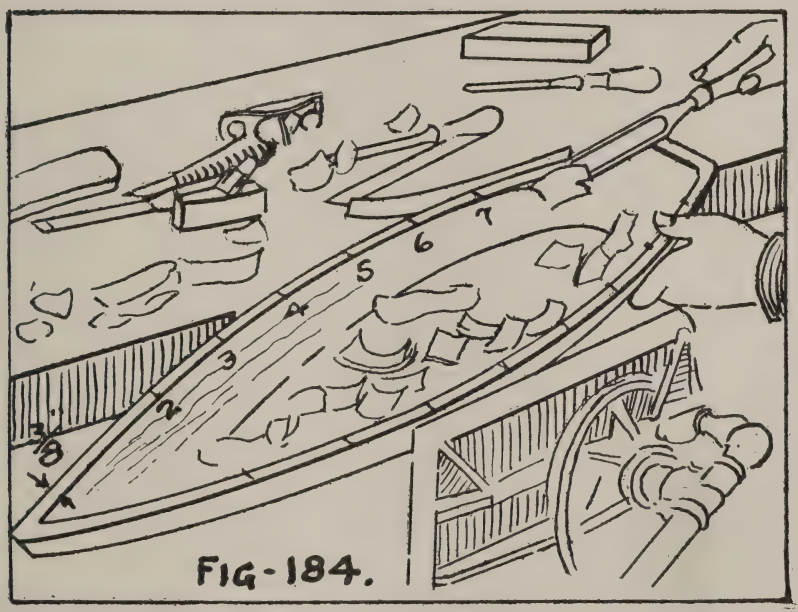
FIG. 183.

on until the hull is shaped up to fit reasonably well on all of the templates. Of course, the process is to be repeated for both sides of the hull and should proceed carefully so that in roughly shaping the hull to the templates you will not cut off too much.

Operation Four—Fig. 183: After the hull has been shaped to the moulds or templates on both sides, use

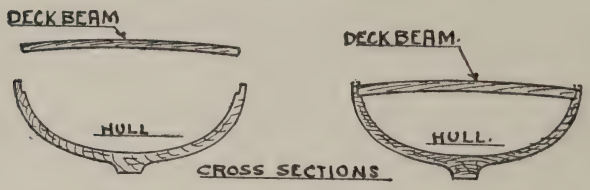
a small plane, set fine, for taking off thin shavings and gradually a little at a time bring the form of hull down to the moulds EXACTLY. The exterior of the hull is now ready to be sandpapered. Use a coarse sandpaper, about number 1, and then finish with finer sandpaper, number 0.

Operation Five—Fig. 184: Now that the exterior of the hull has been shaped the work of gouging out the inside may proceed. Remove the cleat, which is

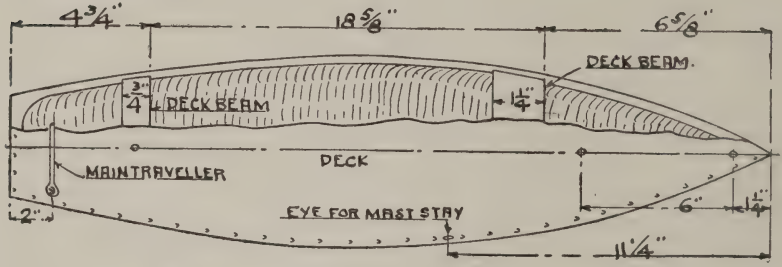


now of no further use. Place the model in the vise right side up, but be sure not to tighten the vise too much. Draw a parallel line to the outside of the hull about $\frac{3}{8}$ in. from the outer edge. This is to be a preliminary guide to prevent digging out too much. Scooping out a hull should proceed carefully for the reason that if you attempt to take out too much at

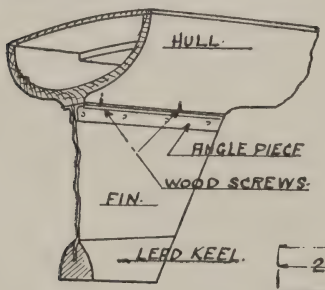
OPERATION #6 · FIG-185.



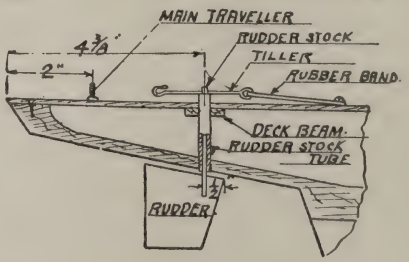
OPERATION #7. FIG-186.



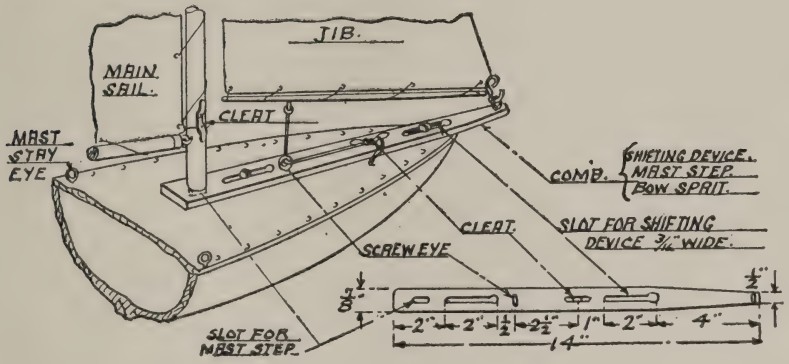
OPERATION #8. FIG-187.

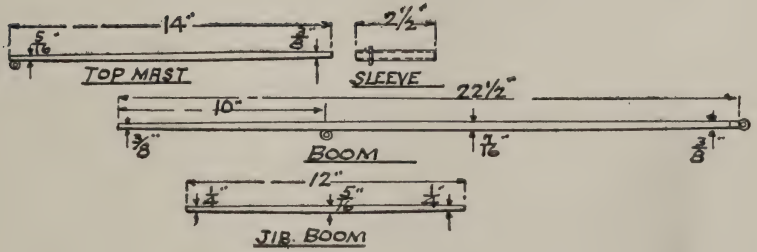


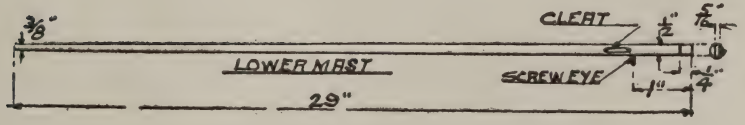
OPERATION #9. FIG-188.

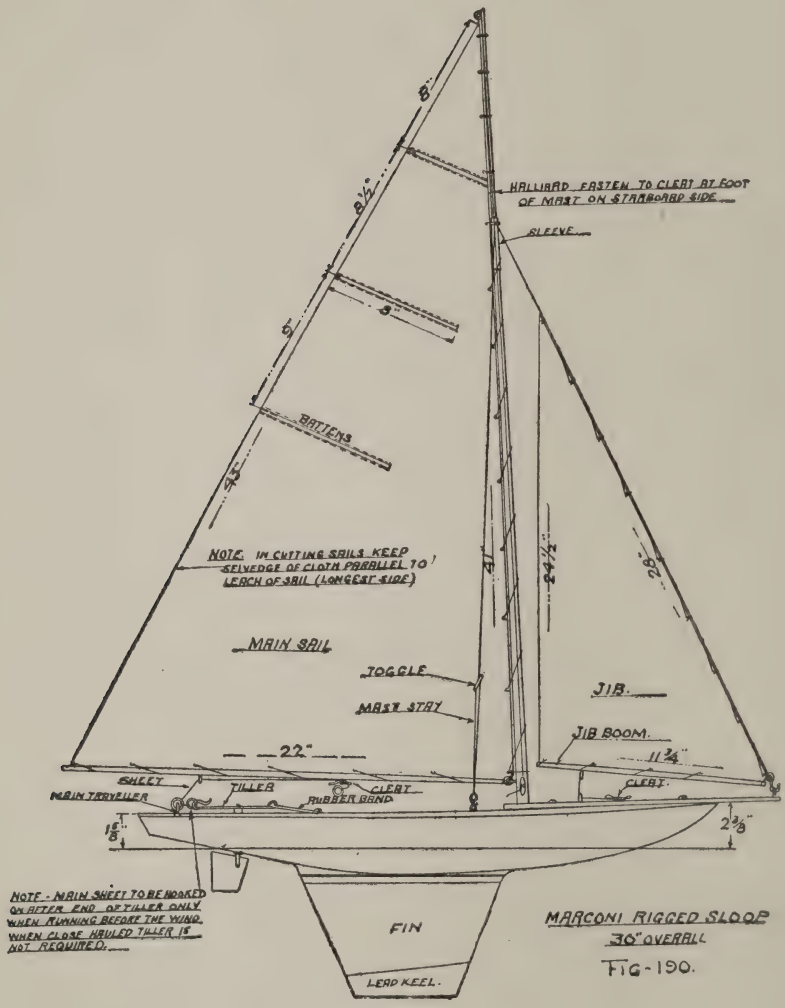


OPERATION #10. FIG-189.









MARCONI RIGGED SLOOP
30" OVERALL
FIG-190.

once you are apt to cut all the way through. The hull should be scooped out to an even thickness of about $\frac{1}{4}$ inch but of course the thinner the hull the better the model will sail on account of the reduced weight.

Operation Six—Fig. 185: Make both deck beams to the proper crown. Cut notches in the hull and fit the beams into them. Bevel the upper edges of the hull to line up with these deck beams.

Operation Seven—Fig. 186: Cut the deck to about the shape required and secure it in place with wire brads. Trim off the edges flush with the sides of the boat. Before fastening the deck down give the inside of the boat and the under side of the deck a coat of paint.

Operation Eight—Fig. 187: Fasten angle pieces to the fin with brass rivets. Make these rivets from brass wire. Secure the fin to the hull with $\frac{3}{8}$ in. countersunk head brass screws. The fin is made from a piece of 22 gauge galvanized iron to the dimensions shown, and a lead bulb, as indicated, is secured at the lower edge.

Operation Nine—Fig. 188: Drill the hole for the rudder-stock tube $4\frac{3}{8}$ in. from the stern and vertical to the deck. Cut the rudder-stock tube to its proper length and screw it in place. Make it a tight fit by the use of a little thick paint. The rudder is made and installed as shown.

Operation Ten—Fig. 189: Make the spars and other fittings, following the dimension and drawings.

Operation Eleven—Fig. 190: This drawing shows the completed boat with sails and rigging. For painting and finishing see the chapter devoted to that subject.

CHAPTER XVIII

THIRTY-SIX-INCH RACING SLOOP AND SCHOONER

These two boats, the thirty-six-inch racing sloop and the thirty-six-inch racing schooner, are the last word in scale model racing yachts. The hulls are of the deep keel type designed for fast sailing in any kind of weather. The beautiful hulls and well-balanced rigs make them, without doubt, the most attractive models ever put on the market. The patented sail shifting device and the nickel-plated bronze fittings put these two boats in a class by themselves. The sails are Ratsey design.

The hulls for the thirty-six-inch racing sloop and the thirty-six-inch racing schooner are identical. The spars and sails are, of course, different. One set of plans and one description is given for building the hulls, but separate sail plans and separate spar details are given for each boat.

The hulls are constructed in five lifts of pattern-makers' white-pine, kiln-dried, waterproof glued and hollowed out, after shaping the outside, to a quarter inch thick wall. This excepts the lower portion, where the lead keel is secured. This is left solid.

The dimensioned profile and deck outline, Fig. 191, together with the full-size patterns, Fig. 192 (Plate 5),* for the frame stations, give ample data for shaping the hull. The full-sized sections should be trans-

* Folding plate in pocket.

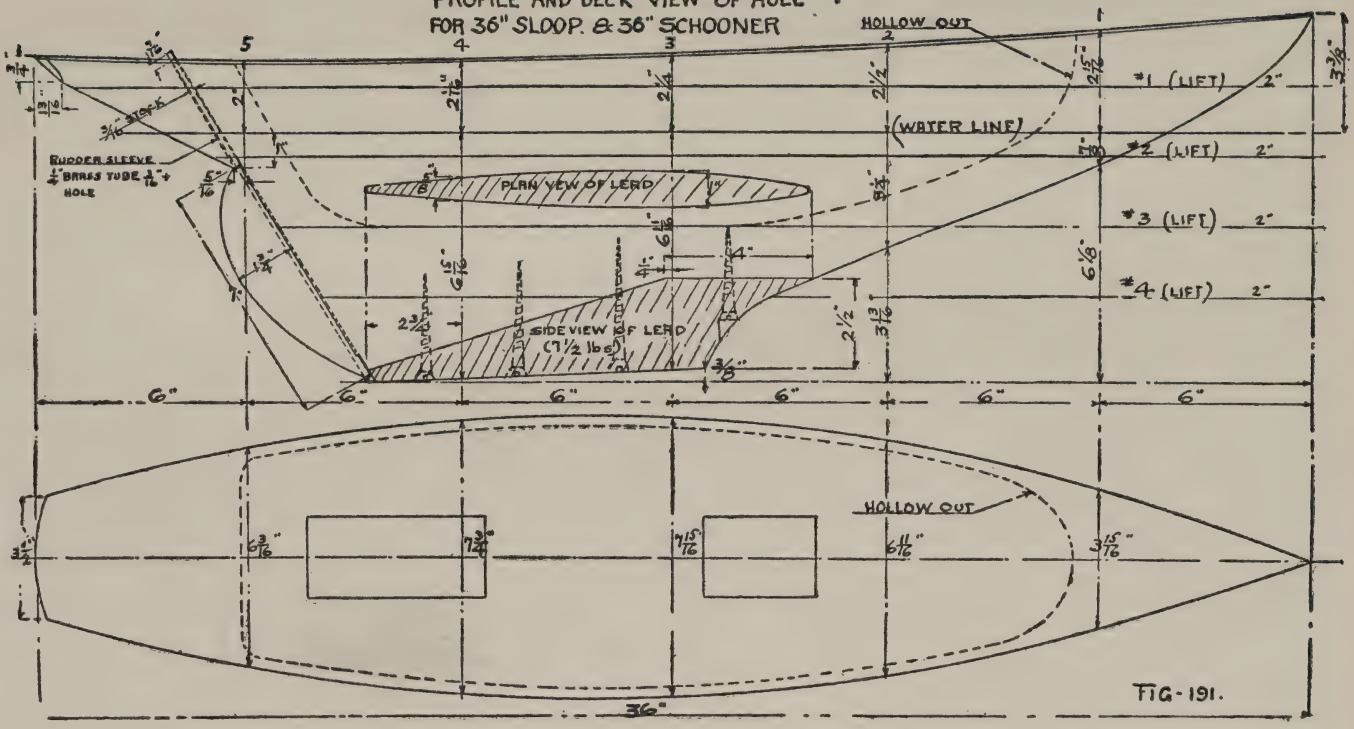

PROFILE AND DECK VIEW OF HULL
FOR 36" SLOOP & 36" SCHOONER
HOLLOW OUT
#1 (LIFT) 2"
(WATER LINE)
#2 (LIFT) 2"
#3 (LIFT) 2"
#4 (LIFT) 2"
RUDDER SLEEVE
BRASS TUBE
HOLE
PLAN VIEW OF LEAD
SIDE VIEW OF LEAD
(7½ lbs)
HOLLOW OUT
6"
36"

FIG-191.

ferred to stiff paper or cardboard and carefully cut out for use in trimming the hull of the boat to the proper lines.

One piece of pine board, nine feet long, eight inches wide and two inches thick, dressed, is sufficient for the hull.

Before starting the work read all of the general chapters, as they explain in detail just how to proceed to transfer the lines (shape) of the boat to the wooden block, how to glue it up, shape, finish, paint, make the spars, the sails and so on.

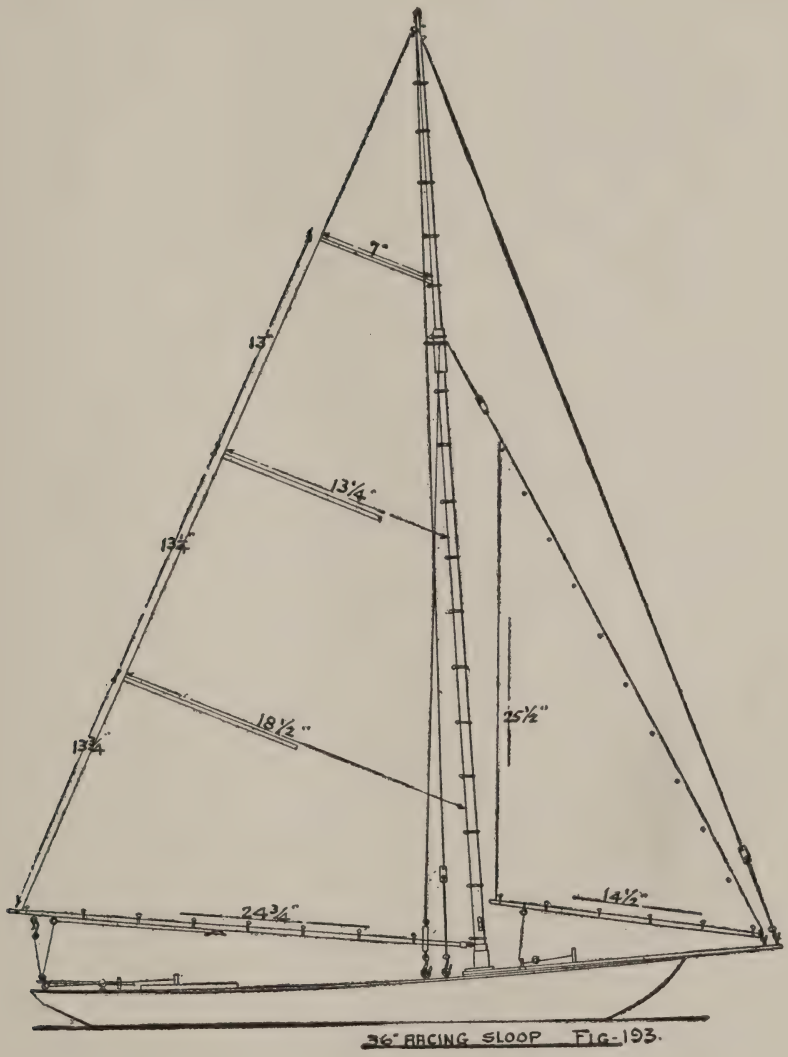
Finish the complete wooden hull and then saw out the portion of the keel which will be of lead. Use the sawed out portion for a pattern for casting the lead.

The deck may be either a $\frac{1}{8}$ in. piece of pine or a piece of three-ply birch veneer. It will be possible to purchase all of the metal fittings, such as the steering gear, mast steps, spreaders, turnbuckles, etc.

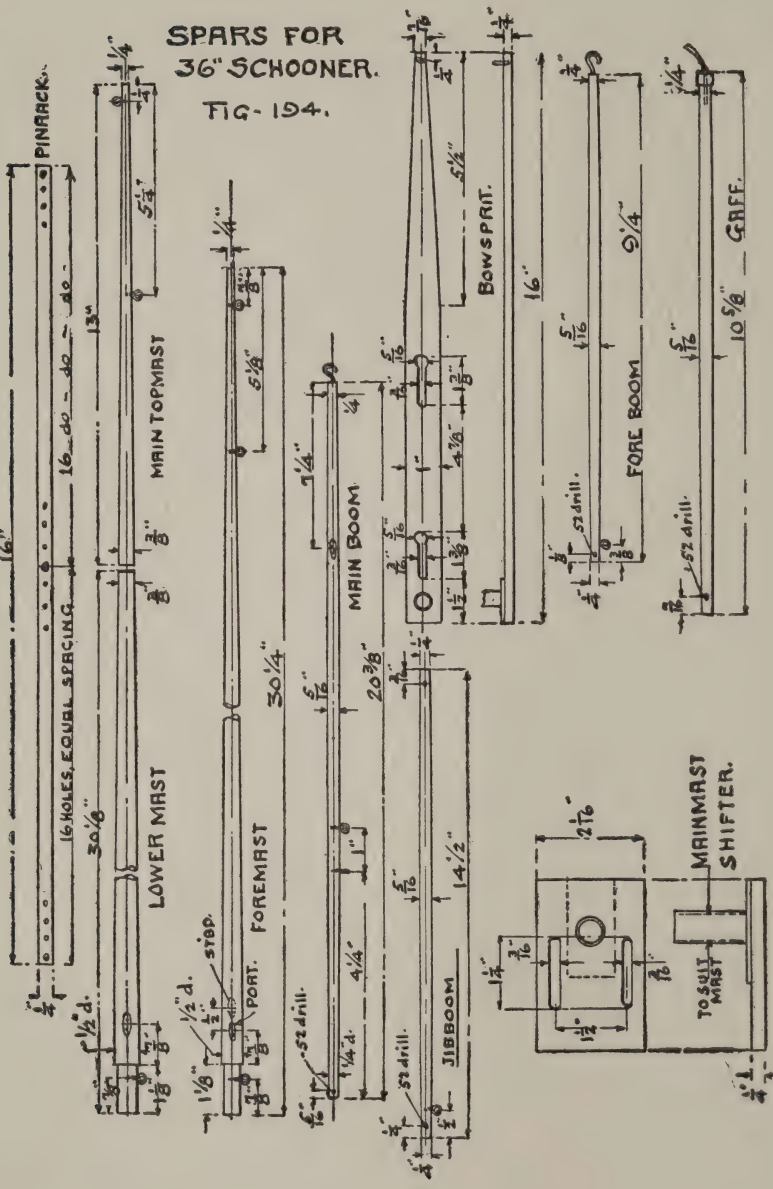
When shaping the hull and applying the templates proceed in a manner similar to the description given for the thirty-inch Marconi sloop. Proceed carefully and above all have both sides of the hull exactly alike.

Before putting the deck on, give the boat several good coats of linseed oil inside and, when dry, a priming coat of lead and zinc paint. Also coat the outside, after it is completely smoothed and finished, with a couple of coats of linseed oil and when it is dry a priming coat of paint. See the chapter on painting. The spars and masts are of spruce, made as described in the chapter on spars. Sails are of balloon cloth, cut to the dimensions shown on the sail plans and spar lists. See the chapter on sails.

THIRTY-SIX-INCH RACING SLOOP



36" RACING SLOOP FIG-193.


SPARS FOR
36" SCHOONER.
FIG. 194.
PINNACK.
16 HOLES, EQUAL SPACING
LOWER MAST
MAIN TOPMAST
FOREMAST
MAIN BOOM
JIBBOOM
BOWSPRIT.
FORE BOOM
GAFF.
MAINMAST SHIFTER.
TO SUIT MAST
PORT.
STBD.
52 drill.

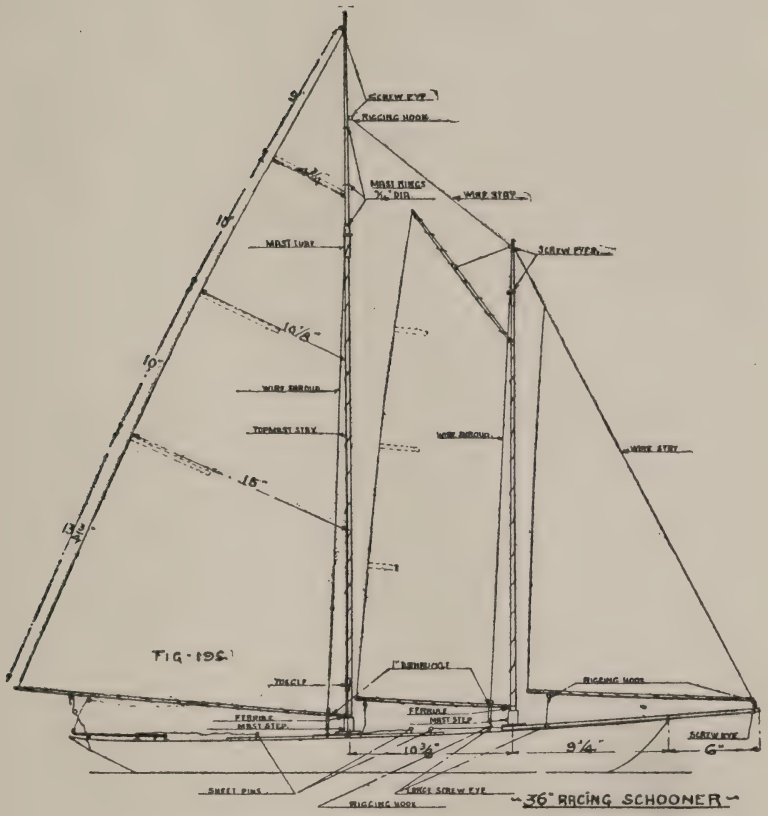


FIG. 19E

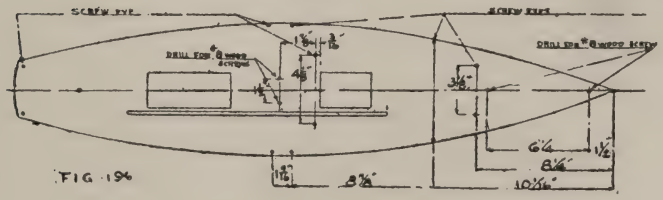


FIG. 19F

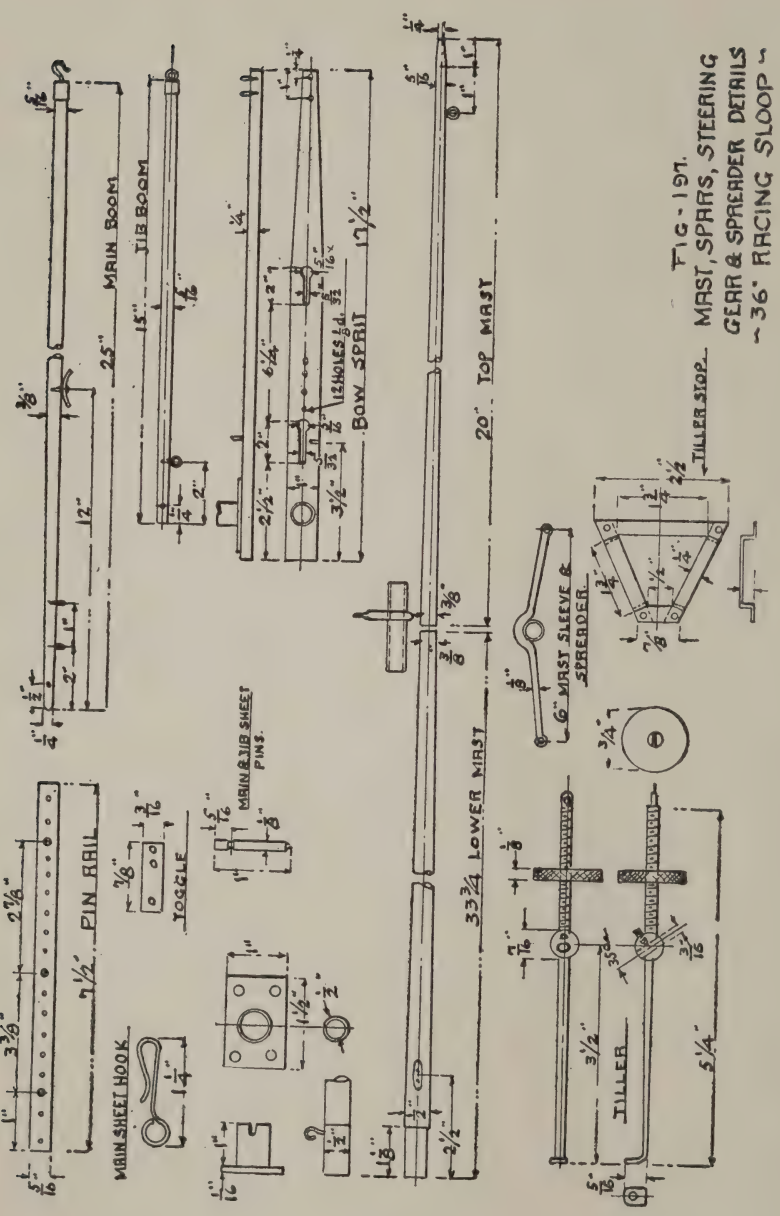


FIG-197.
MAST, SPARS, STEERING GEAR & SPREADER DETAILS ~36' RACING SLOOP~

THIRTY-SIX-INCH SCHOONER

Fig. 193 shows the sail plan for a thirty-six-inch sloop. Fig. 194 gives full dimensioned drawings for the spars and details for the thirty-six-inch sloop. Fig. 195 shows the sail plan for the thirty-six-inch schooner. Fig. 196 is a deck view of a thirty-six-inch schooner and the location of the fittings. Fig. 197 gives full dimensioned drawings for the spars and details for the thirty-six-inch schooner.

Only cursory study of the profile and deck view of the hull will show that the same hull can be used on either type of craft and that the main differences are in the sail plan and the rigging.

CHAPTER XIX

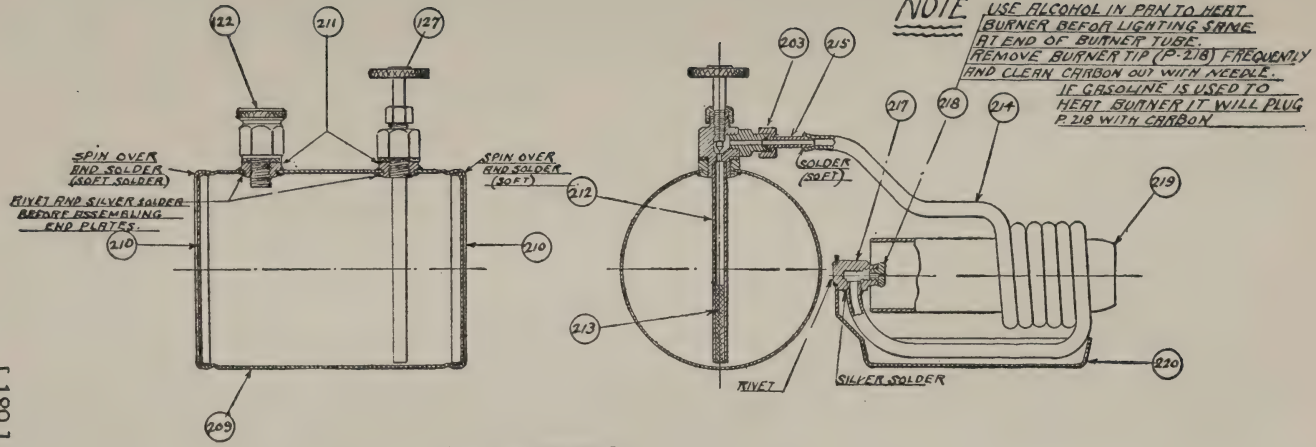
POWER PLANT DESIGN

These power plant designs represent the latest scientific engineering practice. As much care and mathematical calculation and development have been expended on these miniature power plants as would be done in the design of a large boiler or engine. They are not mere toys but the product of the engineering minds.

A properly designed boiler does not represent a can of water under which a light is placed to generate steam, but is a product where the water capacity, exposed heating surface, flue capacity and heat supply bear a definite balanced relation to the maximum drain on the boiler's steam supply, (engine consumption of steam). If this combination is not scientifically worked out there will not be a steady and continuous flow of super-heated steam in sufficient quantity to drive the engine continuously at full speed.

The maximum capacity of the burner in the case of miniature boats must also bear a definite relation to the maximum capacity of the water in the boiler. This is done in order to prevent damage to the boiler by the water being consumed before the heating means is extinguished. The fuel must give out first in case the boat is allowed to run until it stops.

The above combinations have been so successfully



LIST OF PARTS.

	PIECE NO	NAME	NO. REQD.	MATERIAL	REMARKS
	122	AIR CHECK VALVE.	1		
	127	NEEDLE VALVE.	1		
	209	BODY.	1	BRASS TUBE 2 1/2" D.	1/32" WALL.
	210	END PLATE.	2	.035 SHEET BRASS.	
	211	BUSHING.	2	1/2" DIA BRASS ROD.	
	212	FEED TUBE.	1	3/16" HARD COPPER.	
	213	STRAINER.	1	#60 BRASS MESH.	
	214	PIPE COIL.	1	5/16" COPPER TUBE.	
	215	PIPE BUSHING.	1	5/16" BRASS ROD.	
	203	BONNET.	1	5/16" HEX. BRASS.	
	217	BURNER BODY.	1	3/8" SQ. BRASS	
	218	BURNER TIP.	1	5/16" HEX. BRASS.	
	219	BURNER TUBE	1	BRASS TUBE 7/16" DIA.	
	220	PAN	1	.035 SHEET BRASS.	

FIG- 198.
BLOW TORCH
(FOR ALL BOILERS)
- ASSEMBLY-

and efficiently worked out in these little outfits that it is possible to generate sixty or eighty pounds of steam in three minutes, from cold water, when the burner is properly adjusted and opened wide and to maintain this pressure with the engine throttle wide open. There is a slight tendency for the pressure to increase. This fact is evidenced by the boiler safety-valve which will pop frequently during high speed runs.

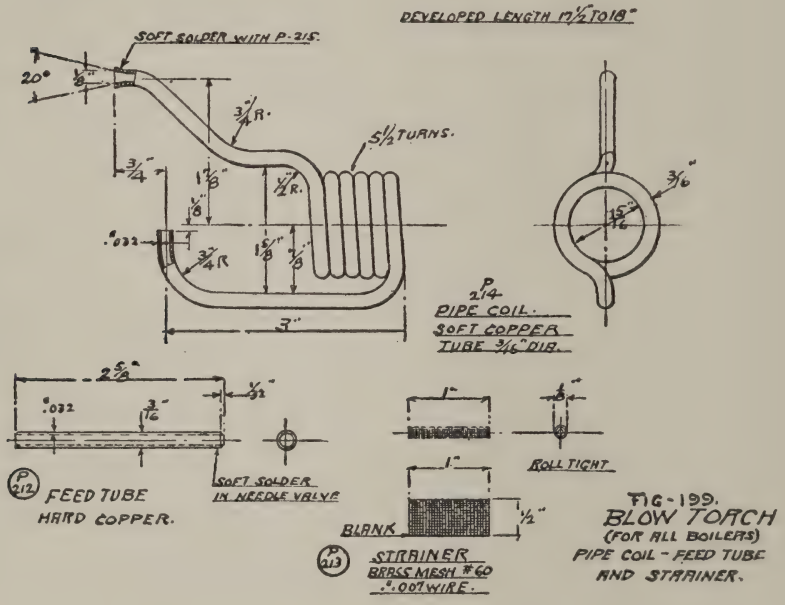


FIG-199.
BLOW TORCH
(FOR ALL BOILERS)
PIPE COIL - FEED TUBE
AND STRAINER.

The power plants are specially designed for the specific boats mentioned and when operated properly they will develop the speed specified.

All of the fittings on the boilers, burners and engines are specially designed for the units to which they are fitted, consequently they are in proper scale proportion to large boilers.

The boiler fittings, steam-dome, super-heater, steam-gauge, water-gauge, combination safety valve and filling plug, all are in the exact proportion they should be, and each is made and tested in exactly the same manner as real ones.

The material used throughout must pass a rigid test and all the boilers that are supplied will have been tested to 150 pounds pressure before delivery. This pressure is impossible to generate in the boiler with the burner supplied. This arrangement, together with the automatic safety valve relief, makes the boilers absolutely safe.

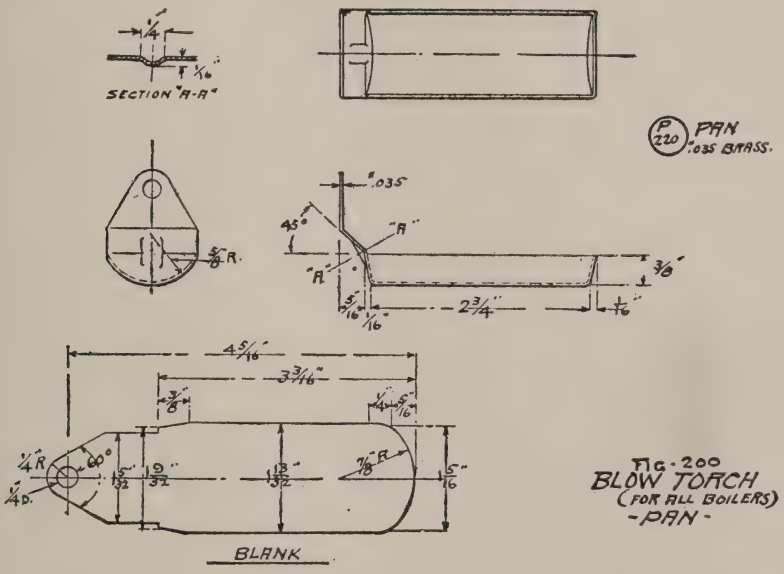


FIG. 200
BLOW TORCH
(FOR ALL BOILERS)
-PAN-

The boilers are actually fitted with tubes which are led down into the firebox or flue. This arrangement accounts largely for the efficiency of the boiler both in quick heating and maintaining a constant and high steam pressure.

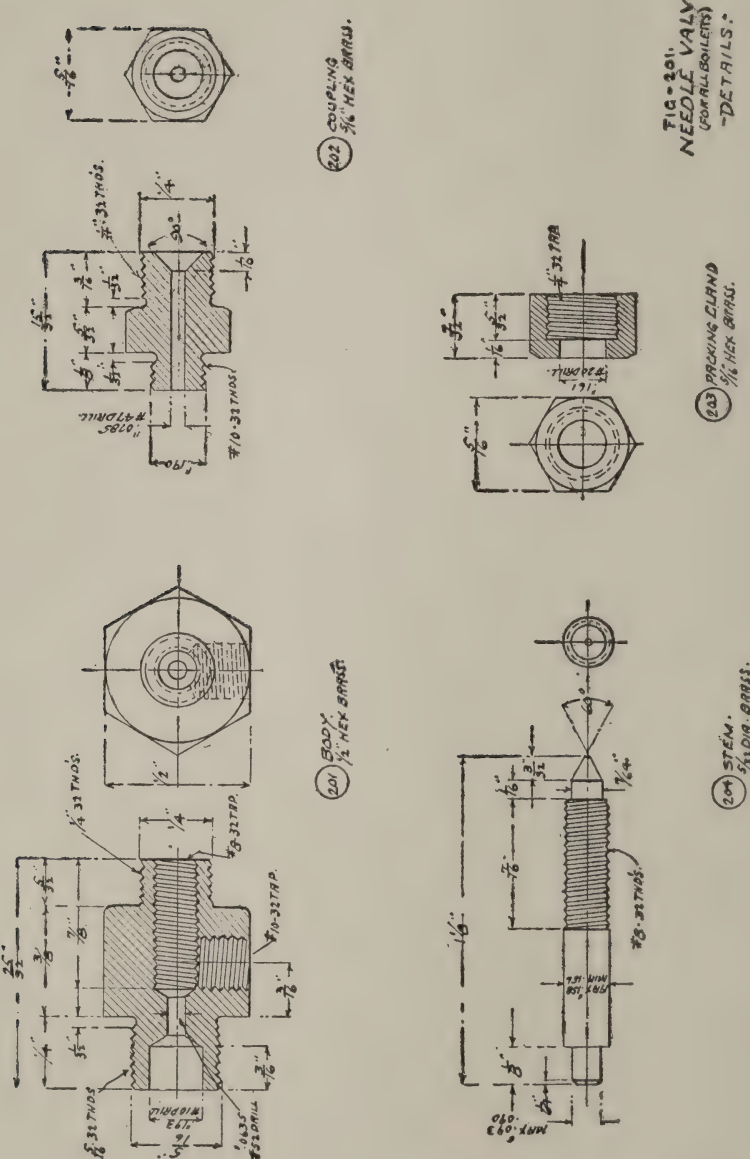


FIG-201.
NEEDLE VALVE
(FOR ALL BOILERS)
-DETAILS.
(201) BODY.
½" HEX BRASS.
(202) COUPLING
⅝" HEX BRASS.
(203) PACKING GLAND
⅝" HEX BRASS.
(204) STEM.
⅛" DIA. BRASS.

- LIST OF PARTS. -

PIECE NO	NAME	NO REQD	MATERIAL
201	BODY.	1	½" HEX. BRASS
202	COUPLING.	1	5/16 " "
203	PACKING GLAND	1	
204	STEM	1	5/32 DIA. BRASS
205	PACKING	1	1 ASBESTOS STRING
146	HAND WHEEL	1	¾ DIA. BRASS.
148	PIN.	1	3/64 BRASS.
177	GASKET	1	⅛" PACKING NUT

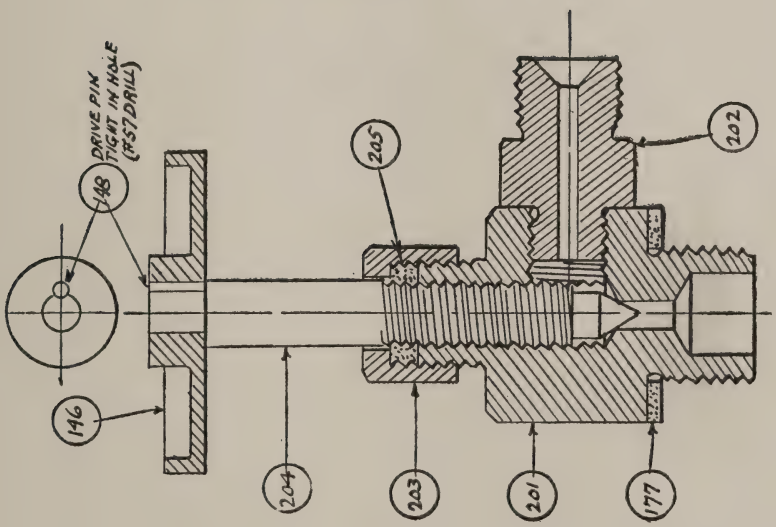


FIG. 202.
BLOW TORCH
= FOR ALL BOILERS =
- NEEDLE VALVE -

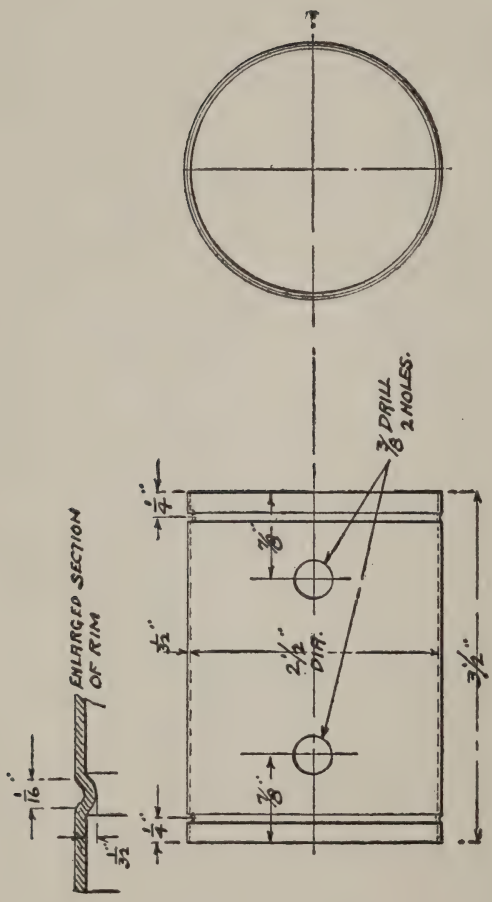
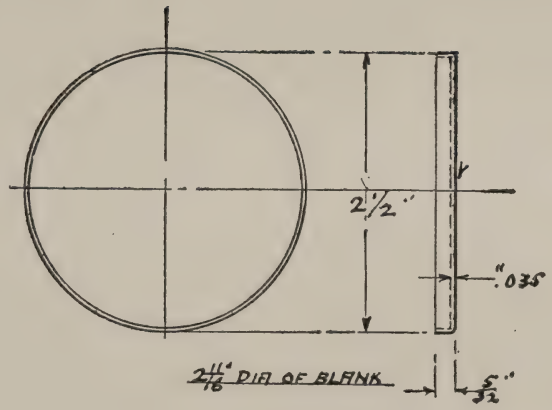
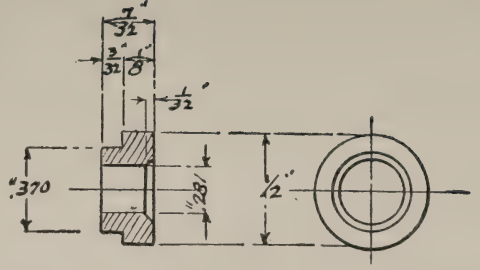


FIG. 203.
BLOW TORCH
(ALL BOILERS)
-DETAILS-

(209) BODY
BRASS TUBE



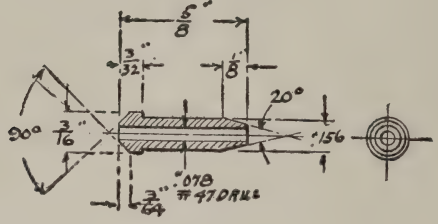
(210) END PLATE
.035 BRASS (3" WIDTH STOCK)



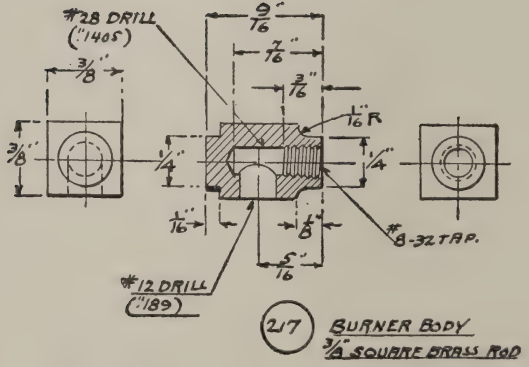
(211) BUSHING
1/2" DIA BRASS ROD

FIG-204.
BLOW TORCH
(FOR ALL BOILERS)
DETAILS.

The engines are accurately designed and balanced as indeed they must be or they would collapse at the high speed at which they are driven. They are automatically oiled by the splash system and also by an ingenious automatic device fitted to the steam supply line.



215 PIPE BUSHING
3/16" DIA BRASS ROD.



217 BURNER BODY
3/8" SQUARE BRASS ROD

I should not advise the inexperienced amateur to undertake the assembly of a boiler or the blow torch, but the assembly of the engines from the machined castings is well within the capacity of anyone who

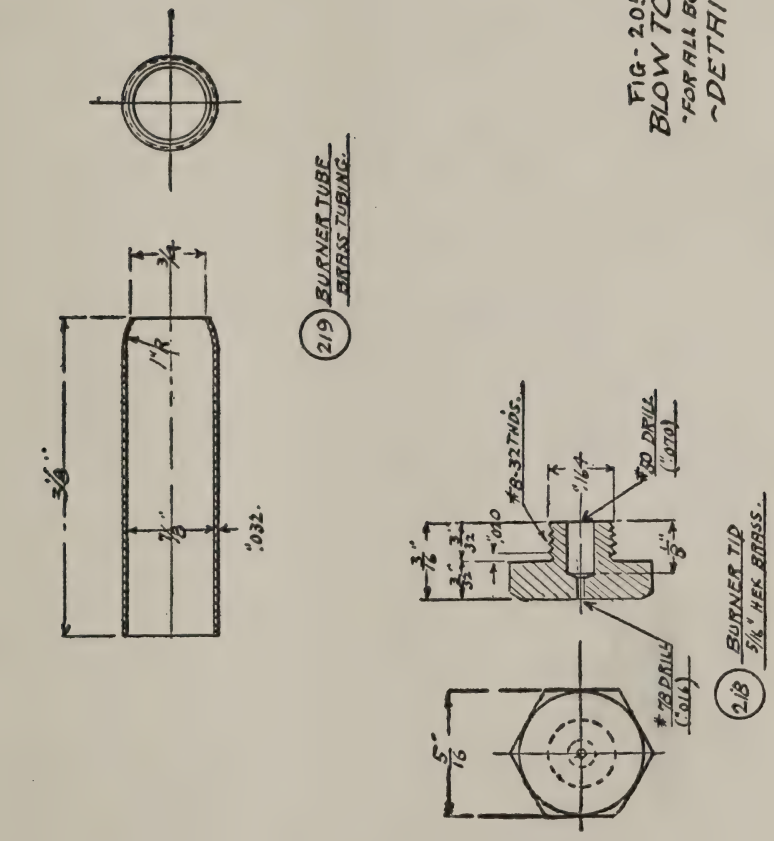


FIG. 205.
BLOW TORCH
-FOR ALL BOILERS-
-DETAILS.-

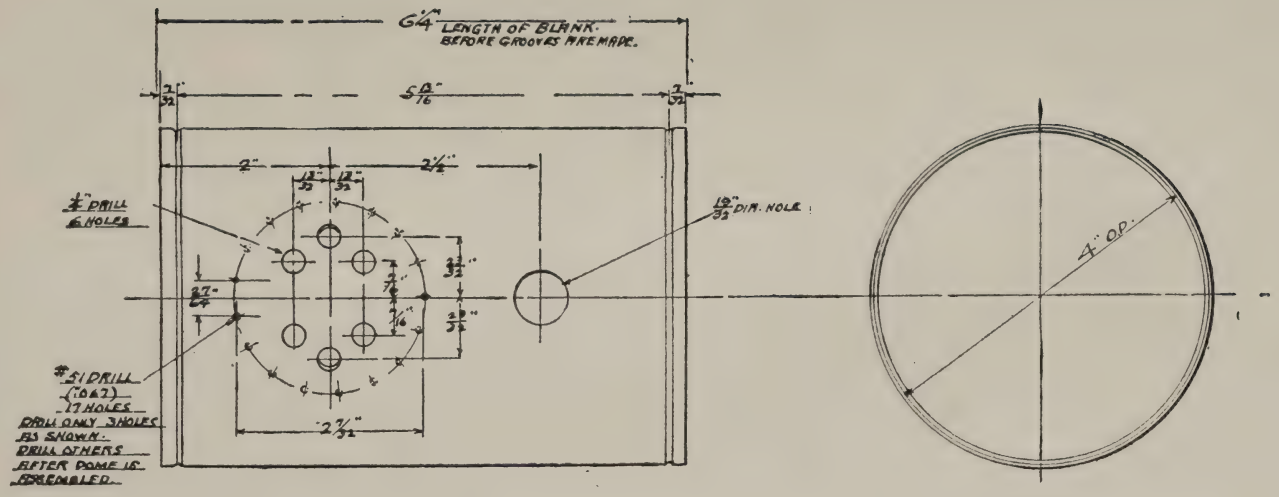
HORIZONTAL BOILER CF-1.
6" LONG
ASSEMBLY

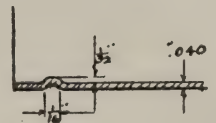
PIECE No	NAME	No REQD
P 232	STEAM GAUGE COMPL.	1
P 234	SAFETY VALVE COMPL.	1
P 237	STEAM RANGE PLUG	1
P 106	FEED WATER PLUG	2
P 238	WATER GAUGE	1
P 239	RANGE RIVETS	17

PIECE No	NAME	No REQD
P 213	SHELL PLATE	1
P 214	FRONT PLATE	1
P 215	REAR PLATE	1
P 216	DOME PLUG	1
P 217	CENTRE FLUE	1
P 218	UPTAKE	1
P 219	WATER TUBE LONG	2
P 220	" " SHORT	2
P 235	STEAM PIPE	1
P 236	DOME BUSHING	1
P 233	UPTAKE SCREW RINGS	1
P 231	WATER GAUGE "	4

PIECE No	NAME	No REQD
/19	¼" PIPE COUPLING	1
/14	SAFETY VALVE	1
/13	WATER GAUGE	1

¼" IRON CASTING


6 4" LENGTH OF BLANK BEFORE GROOVES ARE MADE.
5 A/16"
2"
2 1/4"
#7 DRILL 6 HOLES
#51 DRILL (10 & 7) 17 HOLES
DRILL ONLY SHOLES AS SHOWN. DRILL OTHERS AFTER DOME IS REMEMBLED.
2 7/32"
4" OD.



ENLARGED SECTION OF RIM.

(P 222) SHELL
BRASS TUBING
4" O DIA.
.040 WALL THICK.

FIG-209.
HORIZONTAL BOILER - CF-1.
6' LONG
SHELL.

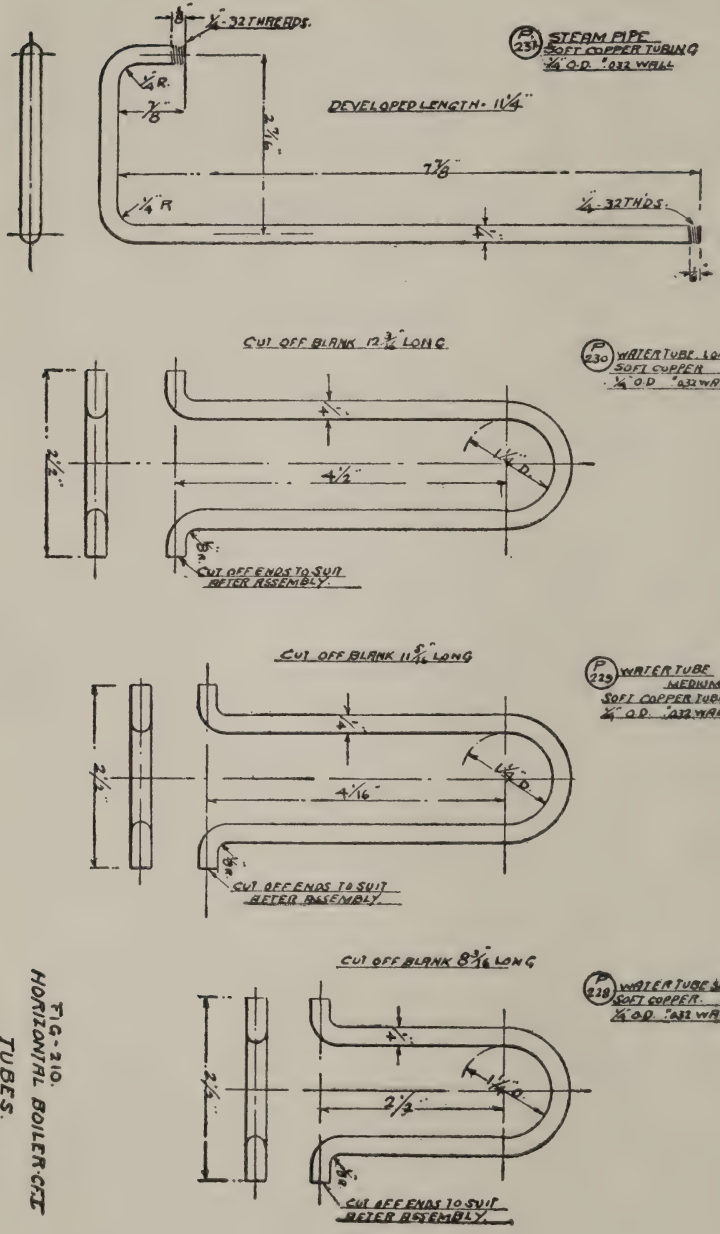


FIG. 210. HORIZONTAL BOILER CCC TUBES. 6" LONG BOILER

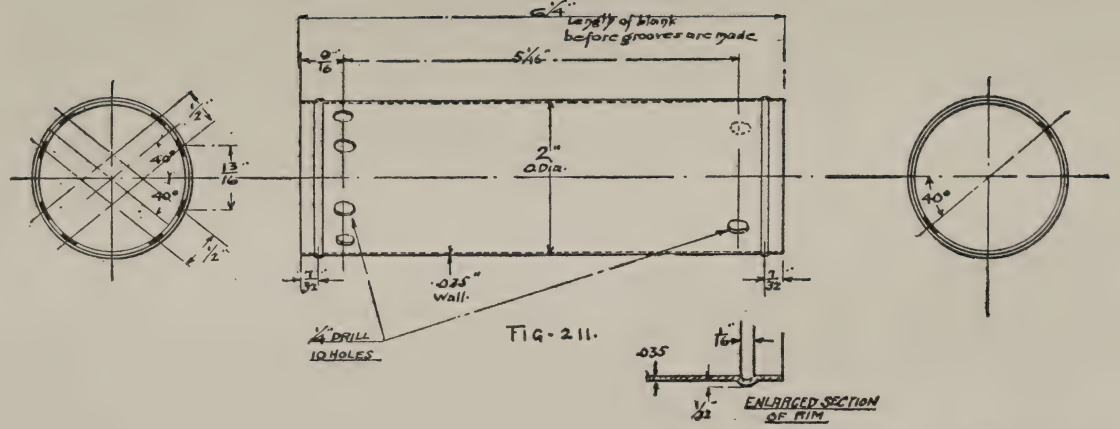
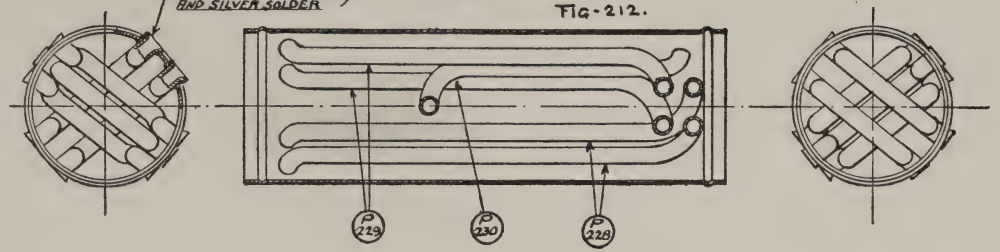


FIG-211.

(P226) CENTER FLUE BRASS TUBE 2" O DIA. .035 WALL.

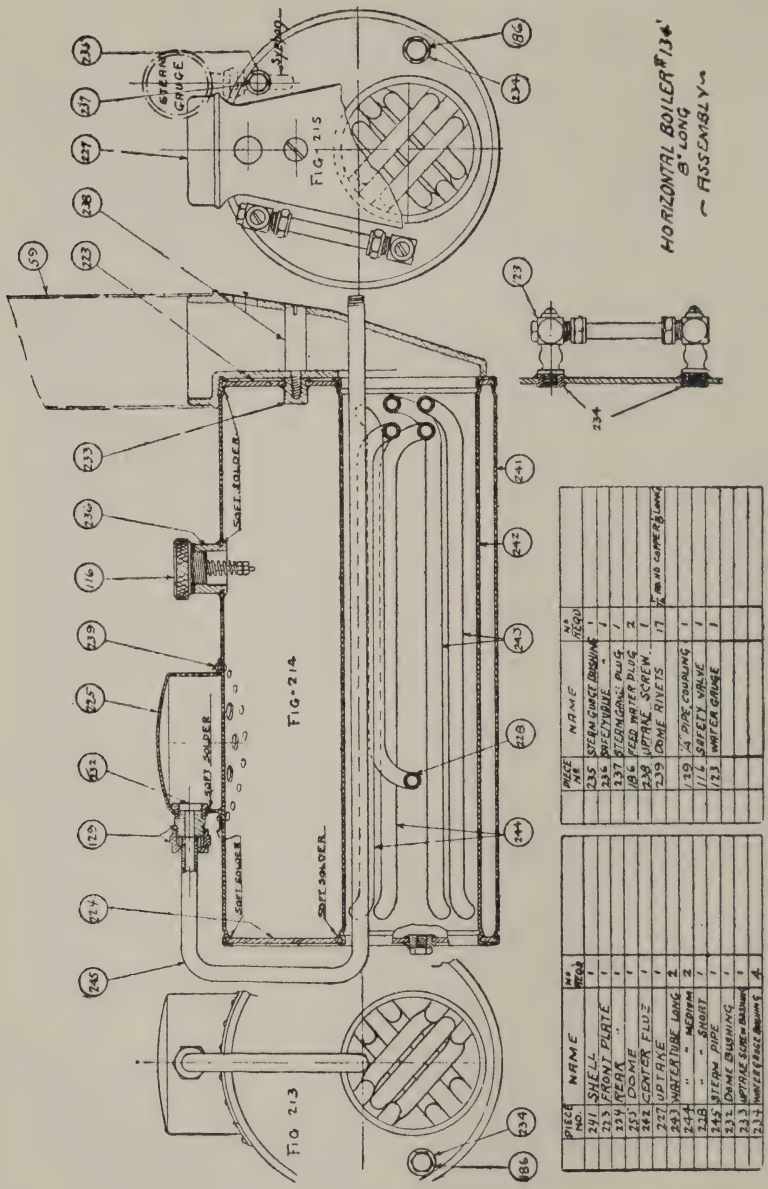


ASSEMBLY

FIG-212.

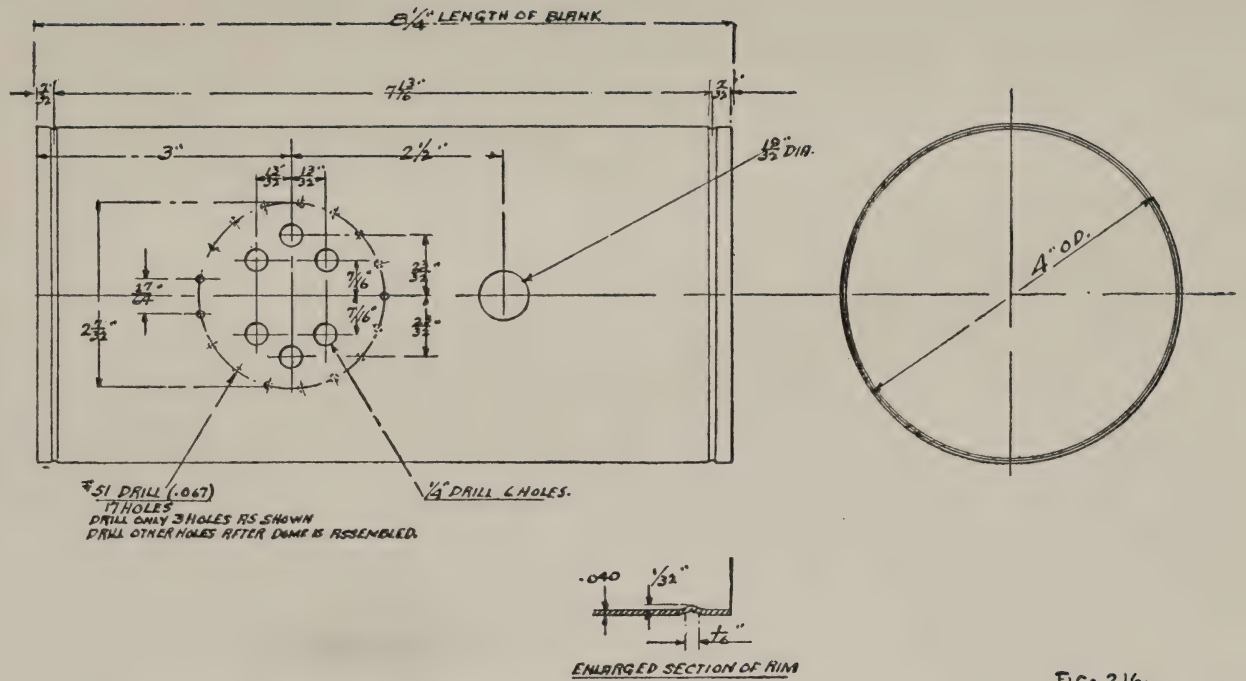
HORIZONTAL BOILER-CF-1

-CENTER FLUE-
6" BOILER



PIECE NO	NAME	NO REQD
241	SHELL	1
223	FRONT PLATE	1
234	REAR "	1
251	DOME	1
242	CENTER FLUE	1
227	UPTAKE	1
243	WATER TUBE LONG	2
244	" - MEDIUM	2
238	" - SHORT	1
245	STEAM PIPE	1
232	DOME BUSHING	1
233	UPTAKE SCREW BUSHING	1
237	WATER GAUGE BUSHING	4

PIECE NO	NAME	NO REQD
235	STEAM GUAGE BUSHING	1
236	SAFETY VALVE "	1
237	STEAM GAUGE PLUG	1
186	FEED WATER PLUG	2
238	UPTAKE SCREW	1
239	DOME RIVETS	17
119	1/4 PIPE COUPLING	1
116	SAFETY VALVE	1
123	WATER GAUGE	1



(24) SHELL.
BRASS TUBING
4" O.D. .040 WALL

FIG. 216.
HORIZONTAL BOILER
8" LONG
~ SHELL ~

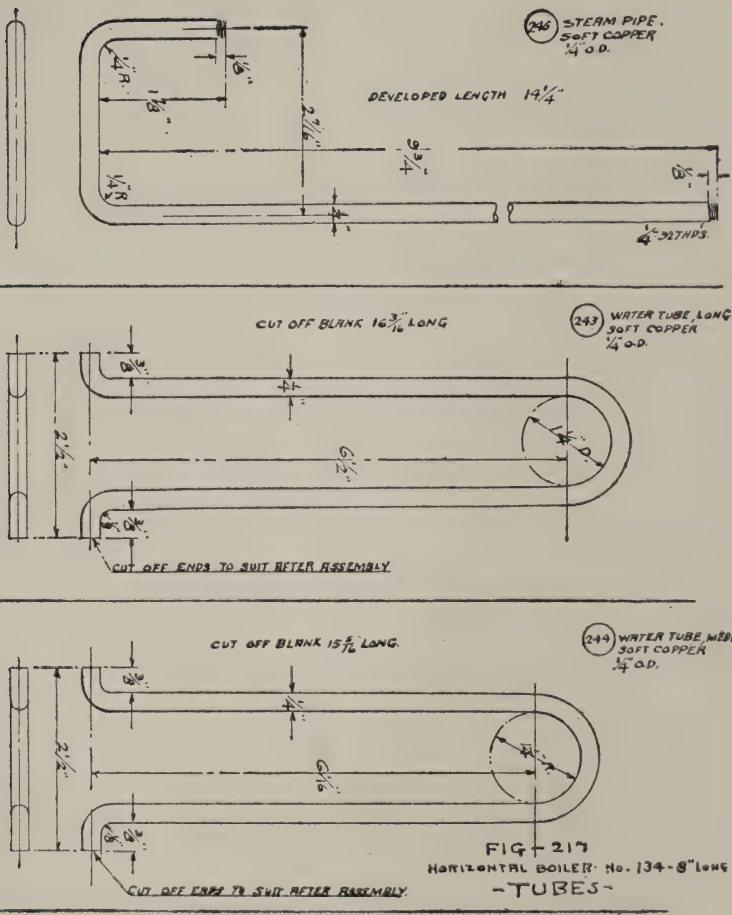
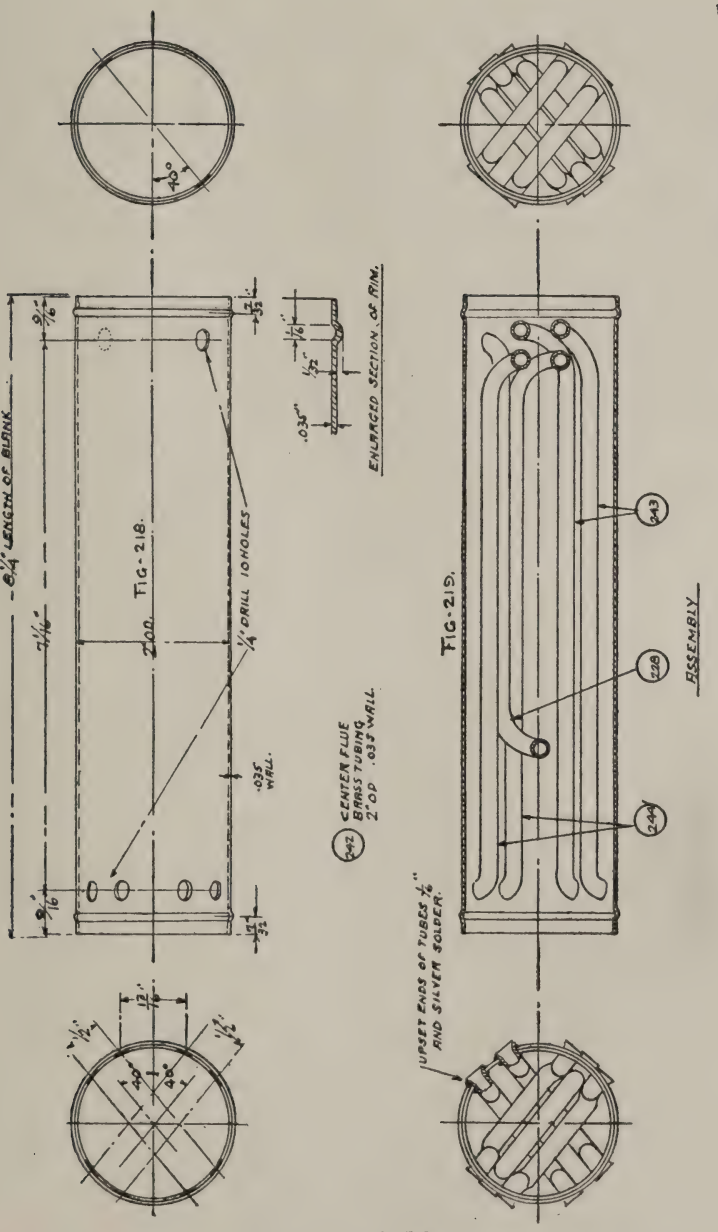


FIG - 217
HORIZONTAL BOILER No. 134 - 8" LONG
- TUBES -


HORIZONTAL BOILER #134
-CENTER FLUE.-
6¼" LENGTH OF BLANK
FIG. 218.
¼" DRILL 10 HOLES
.035 WALL.
ENLARGED SECTION OF RIM.
242 CENTER FLUE BRASS TUBING 2" OD .035 WALL
FIG. 219.
243
238
244
ASSEMBLY
UPSET ENDS OF TUBES 1/16" AND SILVER SOLDER.

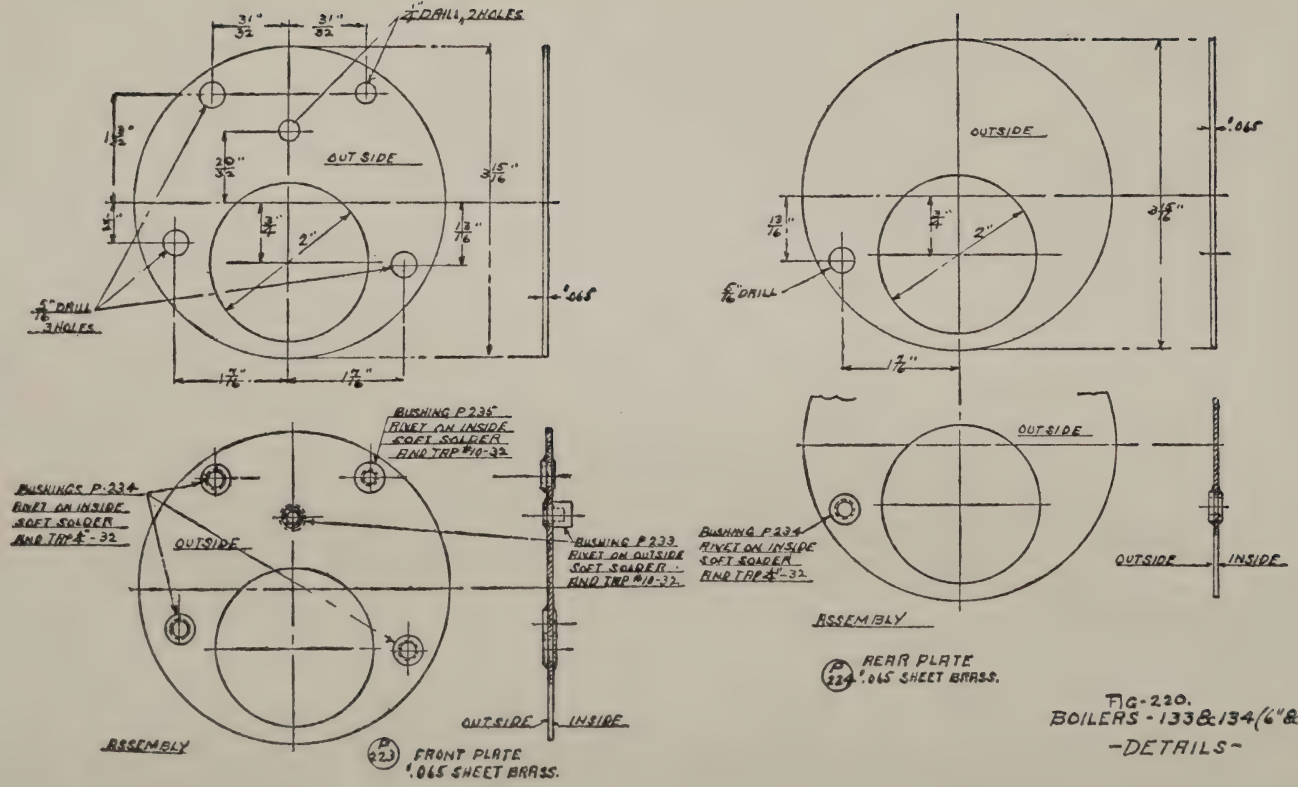
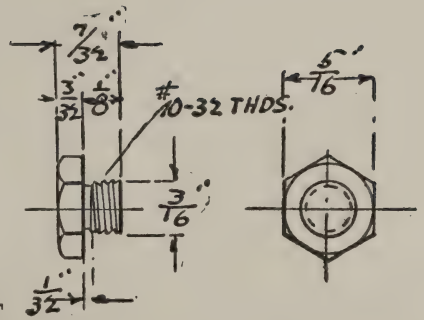

OUTSIDE
BUSHING P 236 RIVET ON INSIDE SOFT SOLDER AND TAP 10-32
BUSHINGS P 234 RIVET ON INSIDE SOFT SOLDER AND TAP 4-32
BUSHING P 233 RIVET ON OUTSIDE SOFT SOLDER AND TAP 10-32
OUTSIDE
INSIDE
ASSEMBLY
P 223 FRONT PLATE .065 SHEET BRASS.
OUTSIDE
.065
2" DRILL 2 HOLES
OUTSIDE
2" DRILL 3 HOLES
OUTSIDE
BUSHING P 234 RIVET ON INSIDE SOFT SOLDER AND TAP 4-32
OUTSIDE
INSIDE
ASSEMBLY
P 224 REAR PLATE .065 SHEET BRASS.

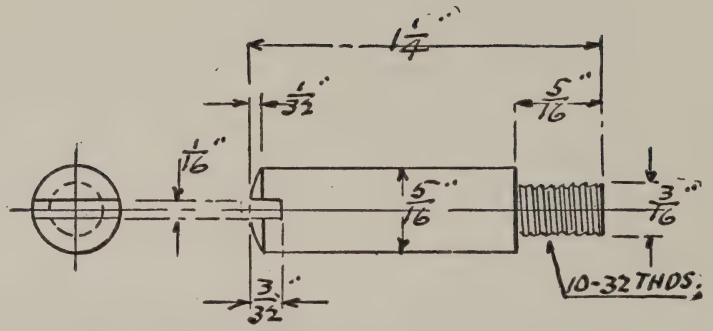
FIG-220.
BOILERS - 133 & 134 (6" & 8")
-DETAILS-

PIECE NO	NAME	NO. REQD	MATERIAL	REMARKS
181	UPPER BODY	1	⅜" SQ. BRASS.	
182	LOWER BODY	1	"	
183	UPPER NIPPLE	1	⅛ O.D. BRASS.	
184	LOWER NIPPLE	1	"	
185	PACKING GLAND	2	⅜" HEX BRASS	
186	CAP SCREW	1	5/16" "	
187	ROUND HD. SCREW	2	BRASS	#5-40, ⅜" LONG
188	GLASS TUBE	1	5/16" O.D. MAX.	
189	PACKING	2	⅛" ASBESTOS SH.	1¼" LONG

FIG-221
WATER GAUGE
BOILERS #133 & 134
- ASSEMBLY -
6" & 8" BOILERS



(237) STEAM GAUGE PLUG
5/16" HEX. BRASS.

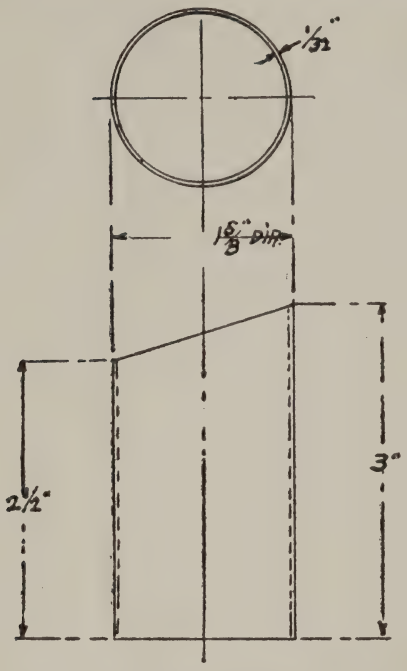


(238) UPTAKE SCREW
5/16" DIA. BRASS ROD.

FIG - 222.
HORIZONTAL BOILERS - 133-134
DETAILS — 6" & 8" BOILERS.

BOILERS 133-134 (6" & 8")
-DETAILS-
FIG-223

builds one of these boats. One having the facilities and ability for machining the rough castings and assembling the parts, could easily negotiate the entire construction of the boiler and blow torch.



(59) FUNNEL (BRASS TUBE)
BOILERS - 133-134
6" & 8" BOILERS

FIG-224.

The construction of the boiler from the pictures and figures given is not as difficult as it is fussy, as the joints must be absolutely tight to withstand the 150-pound pressure test before the boiler is fired.

The special spring drive motor, which eliminates the boiler, blow torch and engine, may be installed in any of the boats, but it will drive them at a reduced speed.

The following is a general rule for the installation of the power plants.

In each power boat there is a shaft hole bored

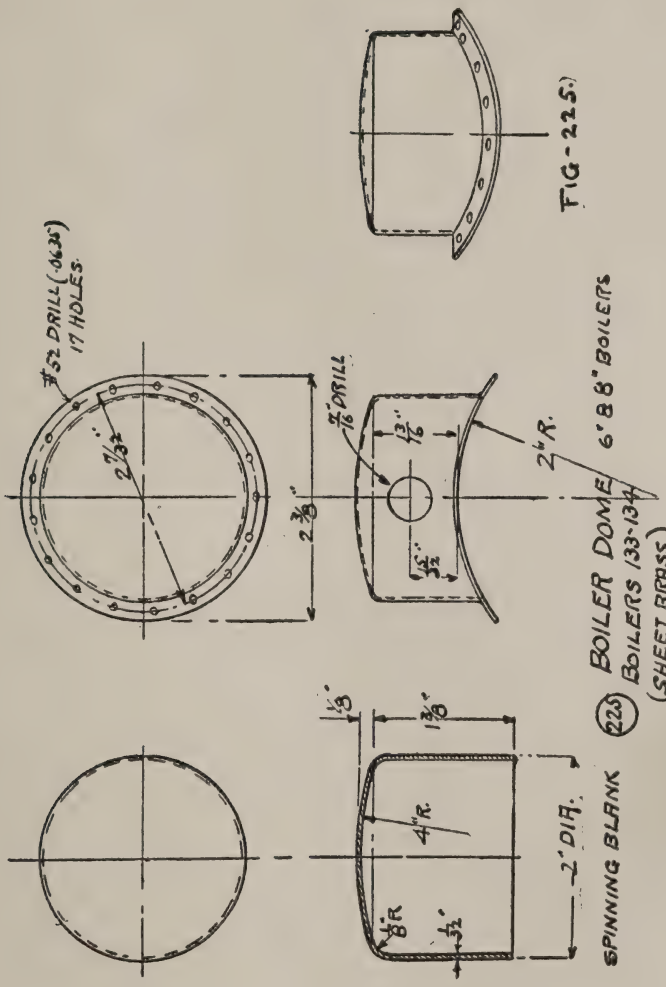
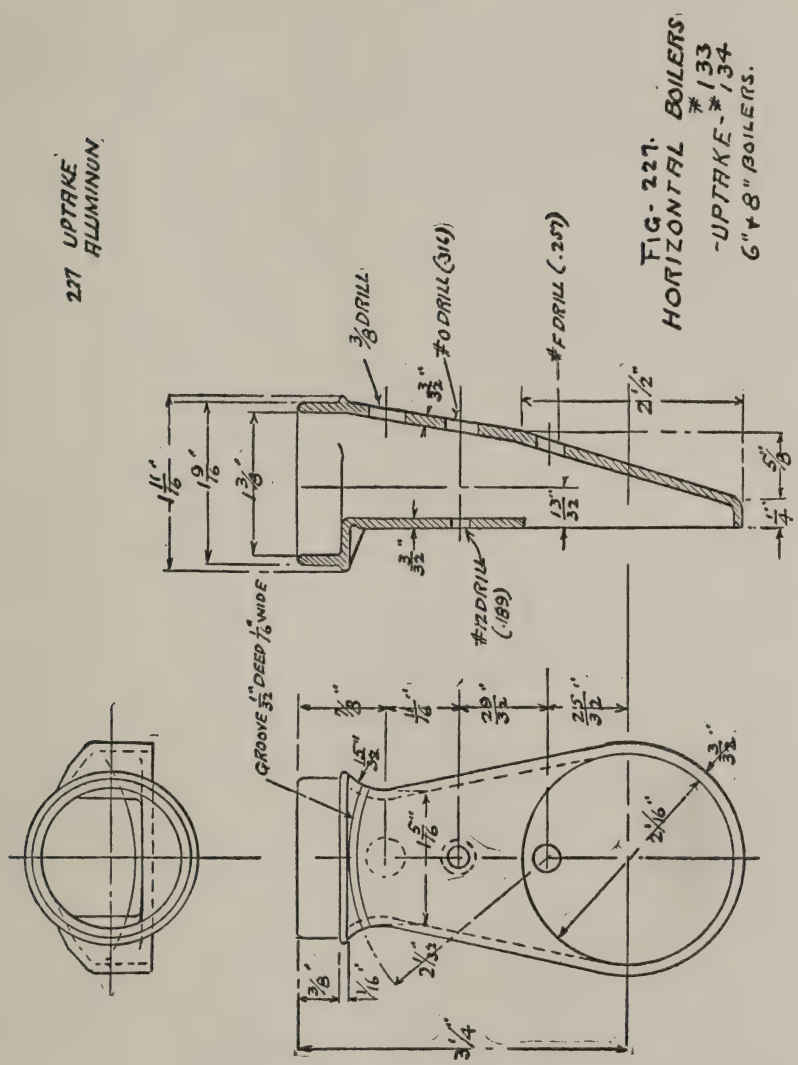

#52 DRILL (.063)
17 HOLES
2 7/32"
2 3/8"
7/16" DRILL
1/2"
2"R.
6' & 8" BOILERS
FIG-225
(225) BOILER DOME
BOILERS 133-134
(SHEET BRASS)
1/8"
1 3/8"
4"R.
1/8"R
1/32"
2" DIA.
SPINNING BLANK

FIG-226.
WATER GAUGE DETAILS
~ BOILERS 133-134. ~
6" & 8" BOILERS


227 UPTAKE
ALUMINUM
3/8 DRILL
#0 DRILL (.316)
#F DRILL (.257)
#12 DRILL (.189)
GROOVE 1/32" DEEP 1/16" WIDE
FIG. 227.
HORIZONTAL BOILERS
-UPTAKE-#133
#134
6"x8" BOILERS.

through the bottom of the boat on a specified angle, given in the figures. The first procedure in installing the power plant is to insert the brass shaft tube in this hole, and in all boats except the twenty-four-inch power boat, cover the palm of this with white-lead and secure it to the bottom of the boat on the outside with six small brass countersunk head screws. Then insert the brass propeller shaft and note whether or not it turns perfectly free. If the tube or the shaft is slightly bent it will not. Next mount the strut piece on the outboard end of the shaft and push it along with the palm up until it touches the bottom of the boat in the position shown on the drawings. The strut is of soft brass and it may be slightly lengthened or shortened by pressing the arms together or forcing them apart a small distance. The palms may also be slightly bent to make a good contact with the bottom of the boat in the proper place. When the strut appears to be correct, press it firmly in place and note whether or not the shaft revolves freely. It must do so, and if for any reason it does not, shift the strut slightly, until it does. When everything is right secure the strut to the bottom of the boat with small brass countersunk screws. The shaft is now mounted in two bearings both of which should be exactly on the fore and aft center line of the boat.

By pushing the shaft into the boat through the two bearings, in which it is now mounted, the exact bevel of the engine bearers may be had. Trim the bearers until, when the engine is held firmly on them, and the shaft is pushed up against the coupling without forcing, it exactly touches in the center of the engine

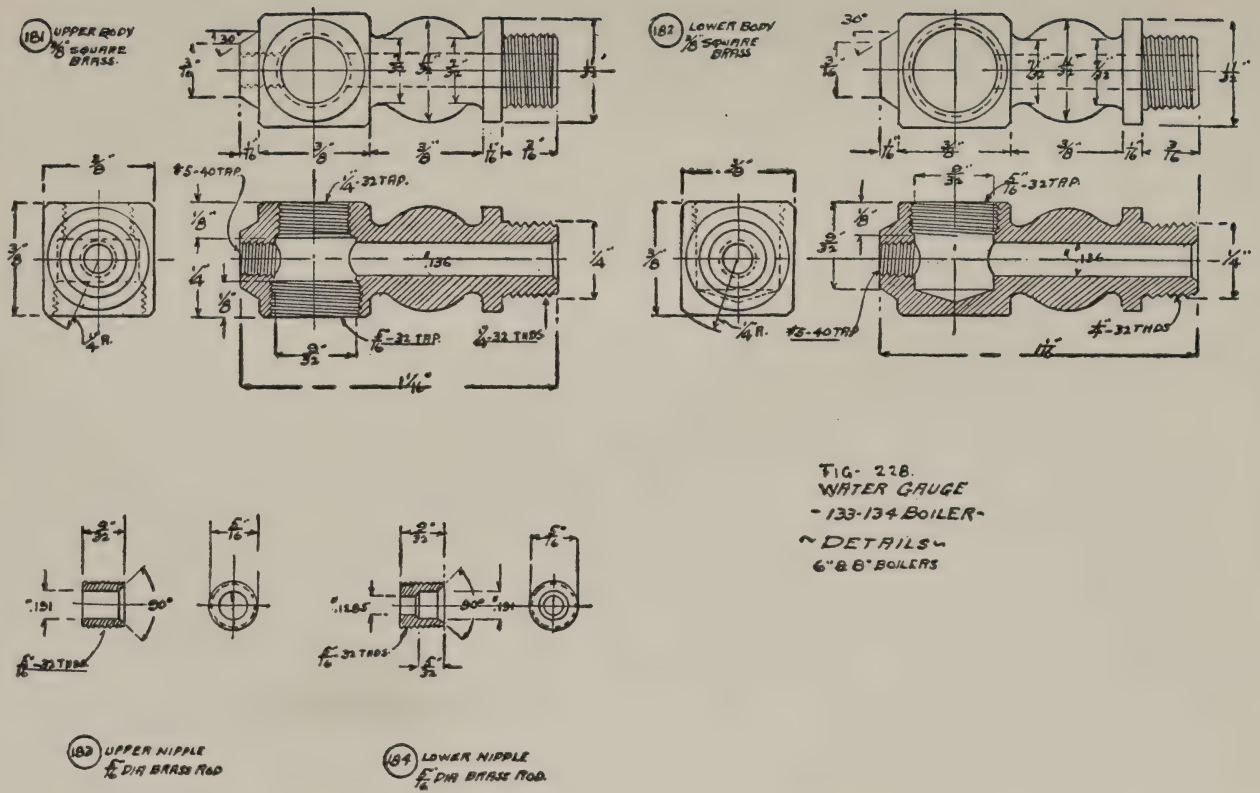


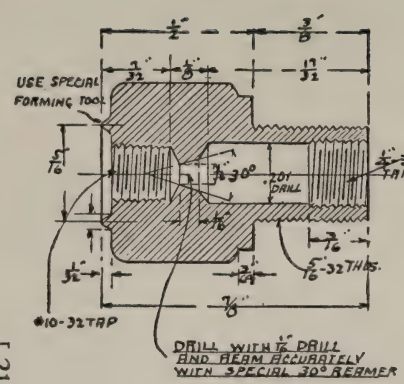
FIG. 228.
WATER GAUGE
- 133-134 BOILER -
~ DETAILS ~
6" & 8" BOILERS

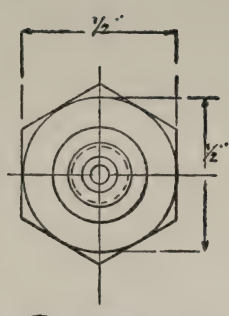
shaft. Then secure the bearers to the boat and the engine to the bearers.

At this point some sort of a cradle, either a finished one or a temporary one should be made, in which the boat can rest so that it will be in no danger of bending the shaft or the propeller or damaging the rudder. This cradle must be high enough to prevent the propeller or the rudder touching the bench or table on which the boat may be placed.

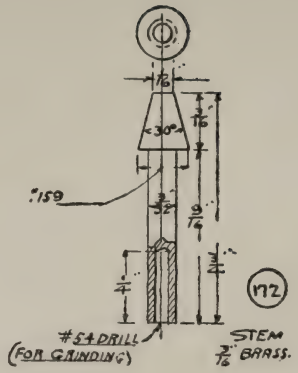
A simple form of cradle, or chock, as they are sometimes called, consists of two vertical pieces of wood about $\frac{3}{8}$ in. thick, the top portion being put in a shape to fit the bottom of the boat at a point about 6 in. forward of the half length and the other piece about 6 in. aft of the half length of the boat. The two chock pieces may be joined by two or three $\frac{3}{8}$ in. dowels, disposed fore and aft, between them. This gives a chock or cradle 12 in. long. In width they should extend from chine to chine. The portion in contact with the bottom of the boat should be smooth or covered with soft leather.

Up to the present time neither the propeller, thrust bearing or universal joint has been fitted. The thrust bearing is disposed between the inboard end of the shaft tube and the engine, for the purpose of taking the forward push of the propeller as delivered through the shaft, in order to prevent this thrust from coming on the bearings of the engines. All that the engine has to do is to rotate the shaft. A small collar-piece is pinned to the shaft and this collar pushes against the after end of the thrust bearing, the latter being secured to the after ends of the engine bearers by a flat strip of brass that bridges the two as shown.

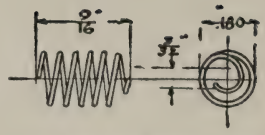




(171) BODY
1/2" HEX BRASS

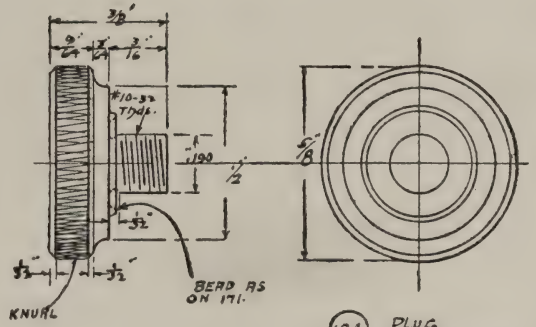


(172)

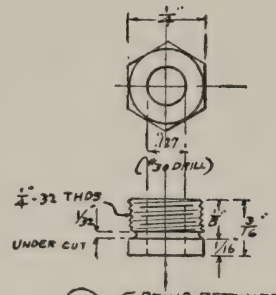


.012 PHOSPHOR BRONZE WIRE WIND ON #39 DRILL ROD MANDREL USE SIX WHOLE TURNS CLOSE IN LAST COIL AT ONE END TO 3/32 I.D.

(175) SPRING
.012 PHOS. BR. WIRE



(174) PLUG
5/8" DIA. BRASS ROD.



(173) SPRING RETAINER
1/2" HEX BRASS ROD.

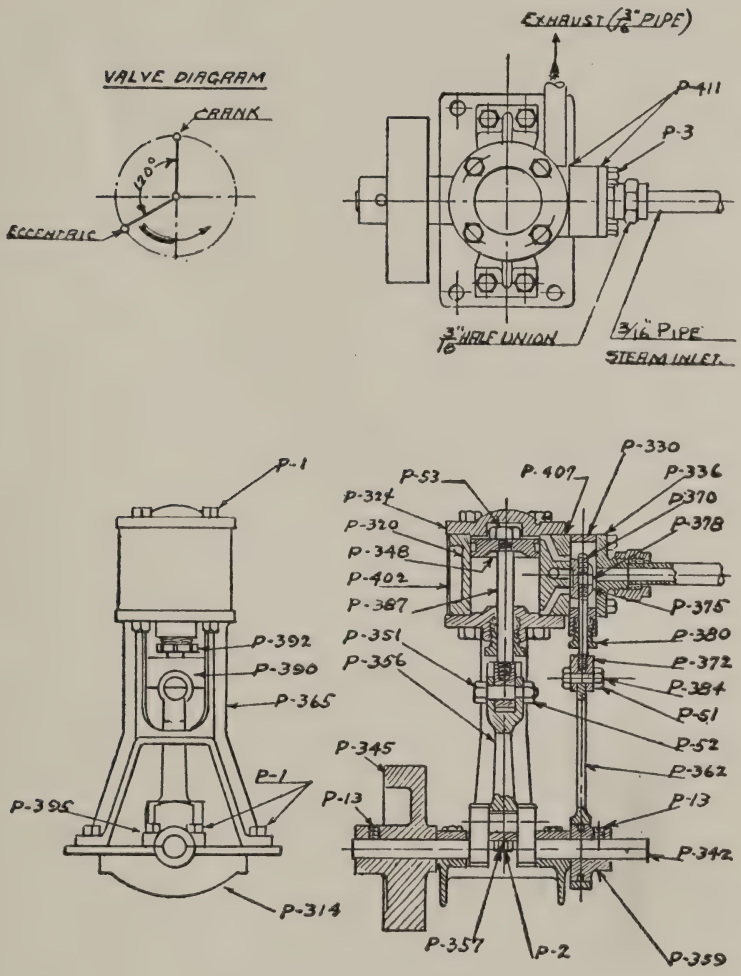
FIG-229.
AIR CHECK VALVE
BOILERS 133-134
~DETAILS~
~FOR 6" & 8" BOILERS~

When securing the supports for the thrust bearing be careful not to force the shaft out of line. The shaft now rotates in three fixed bearings all of which must be perfectly lined.

The universal coupling is in two halves and is for the purpose of providing a somewhat flexible connection between the engine or motor and the propeller shaft. Mount one of the coupling elements on the after end of the engine drive shaft and set up on the set screw. Then mount the other element on the forward end of the propeller shaft and set up on the set screw there. Push the shaft forward, so that the coupling elements engage and then mark the tail end of the shaft for cutting. Allowing for the length that the shaft is to sink into the propeller, plus about $\frac{1}{32}$ in. clearance between the after end of the strut hub and the forward end of the propeller hub. Then cut the shaft with a file or fine hack-saw but be careful not to bend the shaft. Solder the propeller wheel to the shaft.

Make and install the bearers for the boiler and blow torch and secure these bearers to the boat, finally securing the boiler to the bearer. Leave the blow torch so that it can be removed from its bearer **because the blow torch is removed from the boat for filling with gasoline, pumping with air, and preheating with alcohol. Never do any of these while the torch is in the boat or you will surely set the boat on fire. Never fill the torch when it is lighted. If these rules are observed there is no danger.**

Connect the boiler and engine with the small copper steam pipe after installing the globe shut-off valve and the automatic oiler as shown. Fit the exhaust



1-CYLINDER ENGINE-D-SI
-GENERAL ARRANGEMENT-
FIG-230.

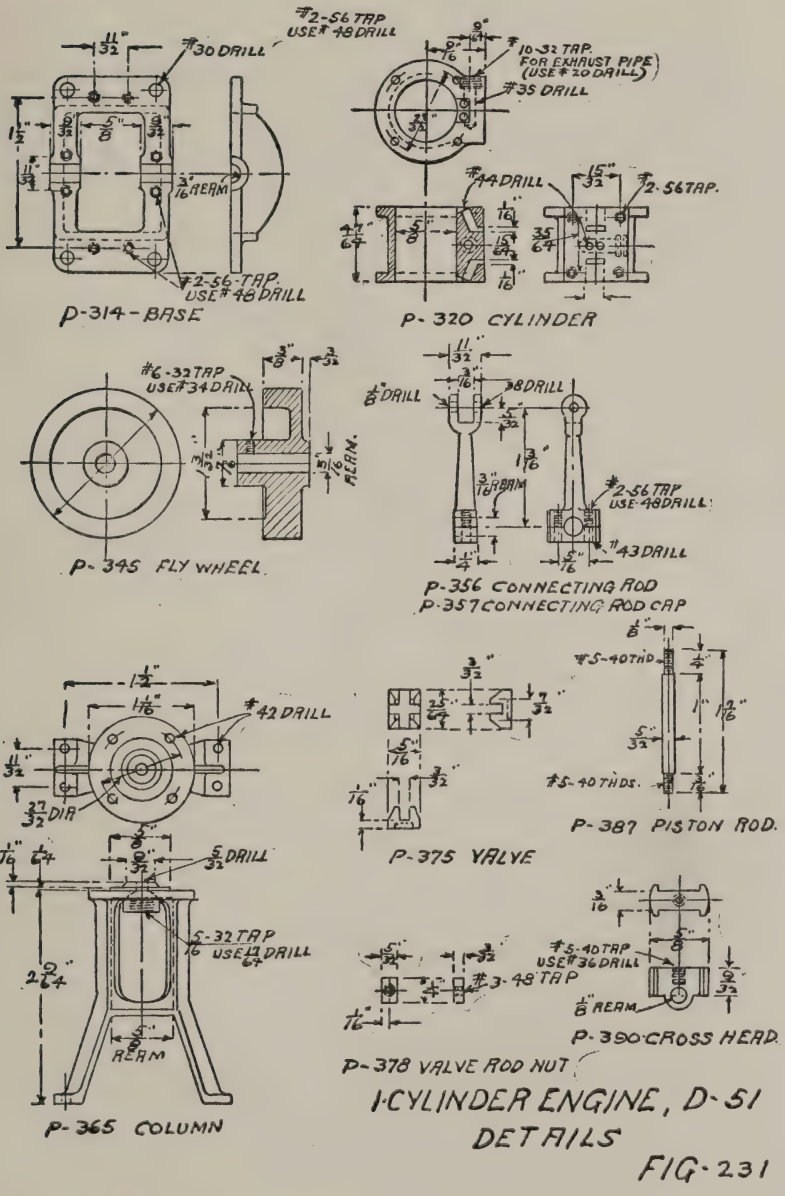
pipe either to exhaust into the smoke pipe or into the air and the outfit is ready to run.

Important. Never run the motor anything like full speed except when the boat is in the water. If this is done it will wreck the engine. No special instructions will be given for making the several parts of the power plants. It will of course be necessary to have a lathe for finishing the parts and considerable machine shop experience. For those that have had this the dimensioned drawings are in complete detail and are all that will be required for making the finished parts from the rough castings.

It is within the ability of the average builder to assemble the parts of the engines from the finished casting sets.

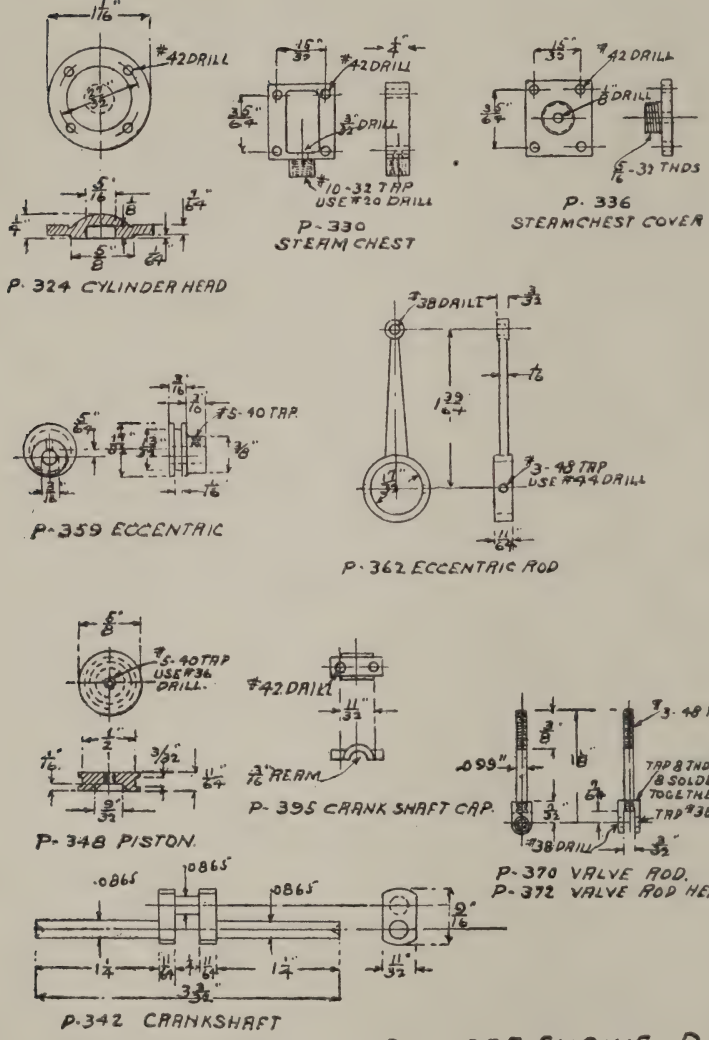
It is not advisable for anyone but the experienced to attempt the construction or assembling of the boilers or blow torches. The complete dimensioned drawings, material schedules, etc., furnish the information, however, for those capable of this work.

In connection with the power plant designs, and their construction, it is suggested that none but those having had machine shop practice undertake their complete construction. Those having had this experience will find the drawings in complete accordance with the standard practice for such work. For each unit, six-inch boiler, eight-inch boiler, blow torch, and the one-, two- and four-cylinder steam motors, there is a complete general arrangement view, with each piece marked by a number and a reference table giving the name. In addition, each part is detailed on separate sheets, fully dimensioned for making patterns, machining the parts and assembling



1-CYLINDER ENGINE, D-51
DETAILS

FIG. 231



1-CYLINDER ENGINE, D-61
DETAILS
FIG-232

LIST OF PARTS

PIECE NO	NAME	NO
252	BASE	1
255	CYLINDER BLOCK	1
257	CYLINDER HEAD	1
259	STEAM CHEST	1
261	STEAM CHEST COVER	1
264	CRANK SHAFT	1
266	FLYWHEEL	1
269	PISTON	2
271	WRIST PIN	2
274	CONNECTING ROD	2
275	CONNECTING ROD CAP	2
276	ECCENTRIC	1
278	ECCENTRIC STRAP	1
279	VALVE ROCKER	1
281	VALVE ROD	1
282	VALVE ROD HEAD	1
284	VALVE ROD NUT	1
286	VALVE	1
287	VALVE ROD GLAND	1
288	PIN FOR VALVE ROCKER	1
16	BOLT FOR VALVE ROCKER	1
15	BOLT FOR ECCENTRIC STRAP	1
53	NUT FOR BOLTS	2
119	OIL HOLE PLUG	1
289	SCREWS FOR ECC. STRAP	2
14	SET SCREWS	2
12	CAP SCREWS	22
—	FLAT HEAD SCREWS	4
292	JACKET	1
	NAME PLATE	1
	RIVETS FOR JACKET	2
	RIVETS FOR NAME	2
	PACKING FOR PISTON	2
	PACKING FOR VALVE ROD	1
299	GASKET FOR CYLINDER HD	1
301	GASKET FOR STEAM CHEST	1
303	GASKET FOR CHEST COVER	1
	WRENCH TYPE A	1

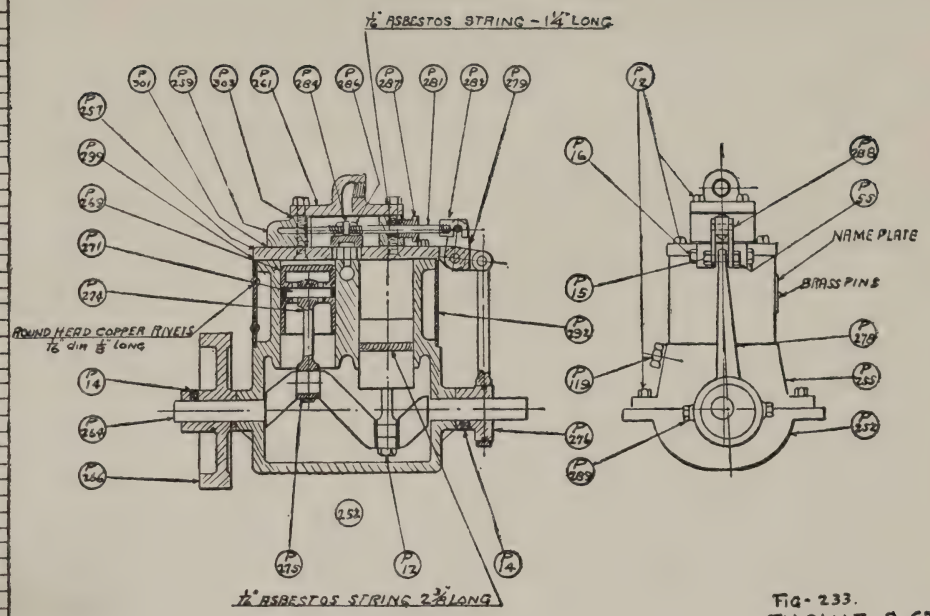


Fig. 233.
ENGINE S-62
ASSEMBLY.

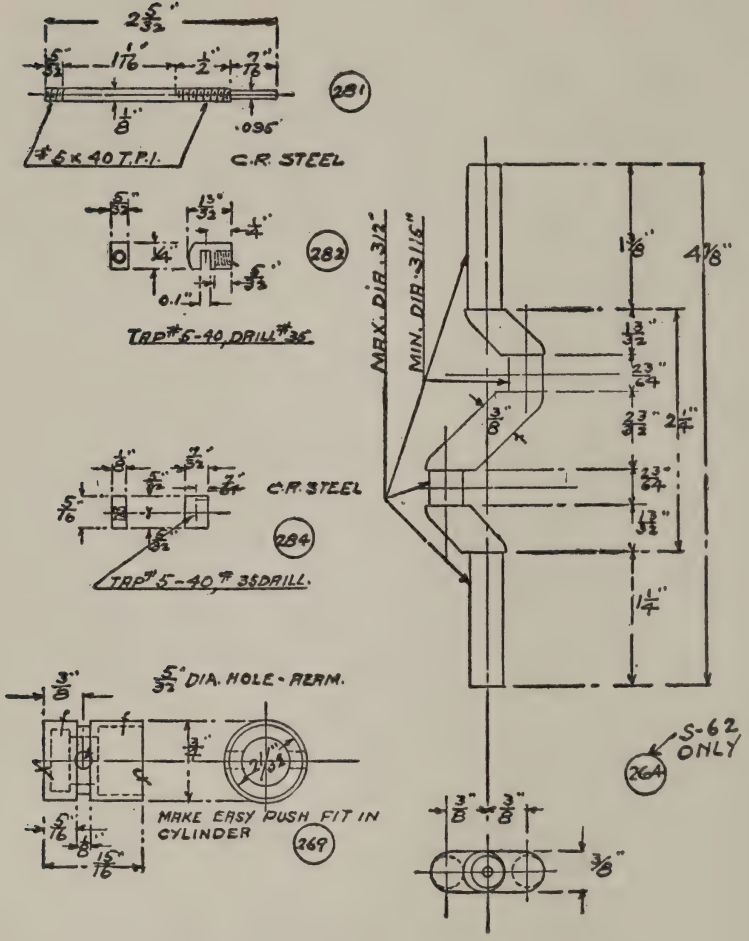
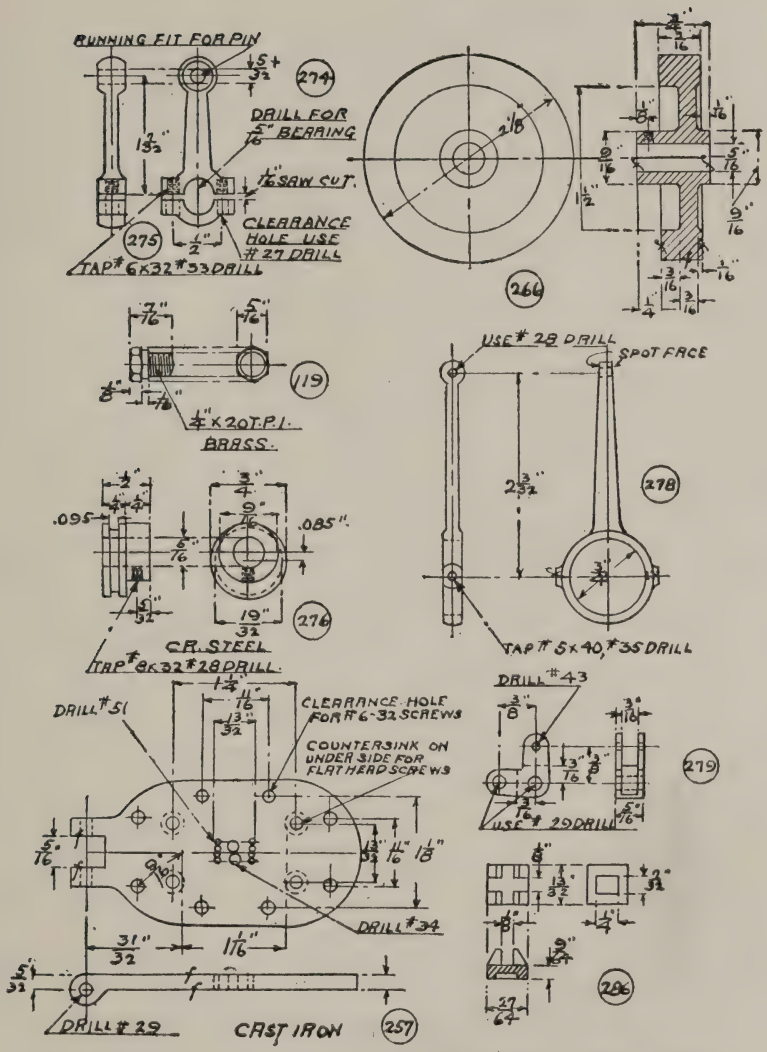
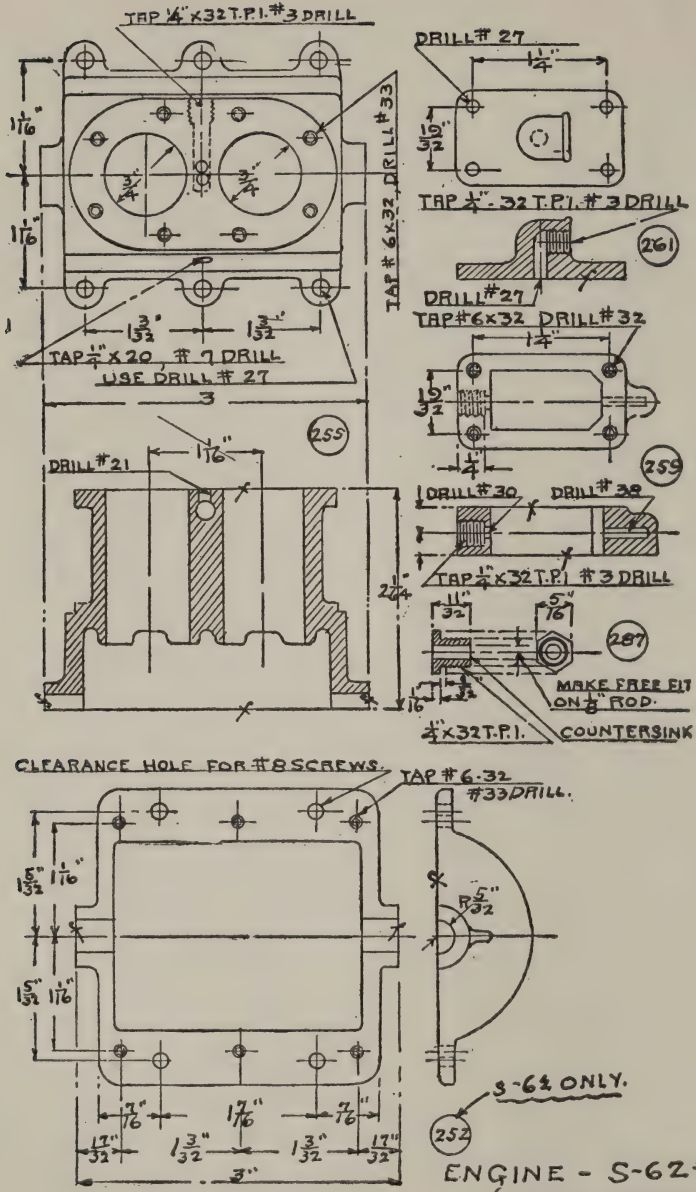


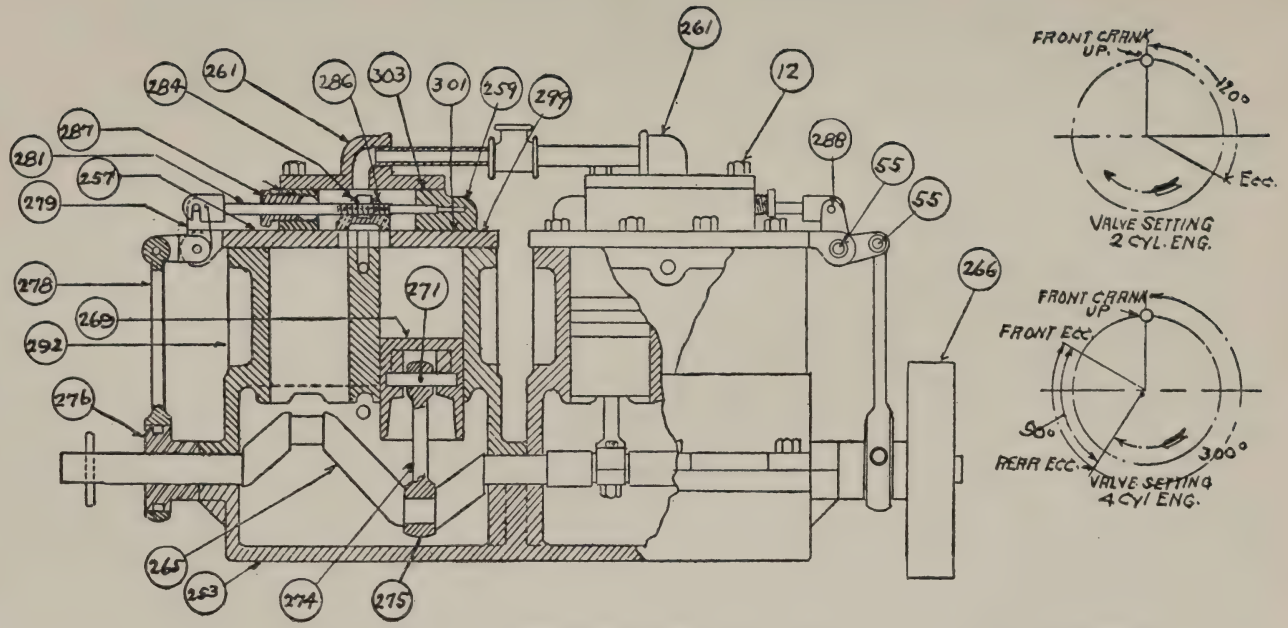
FIG. 234.
ENGINE S-62 & S-64
(2-CYLINDERS)-(4 CYL.)
-DETAILS-



ENGINE S-62 & S-64
(2-CYLINDERS)-(4-CYL.)
-DETAILS-
~FIG-235



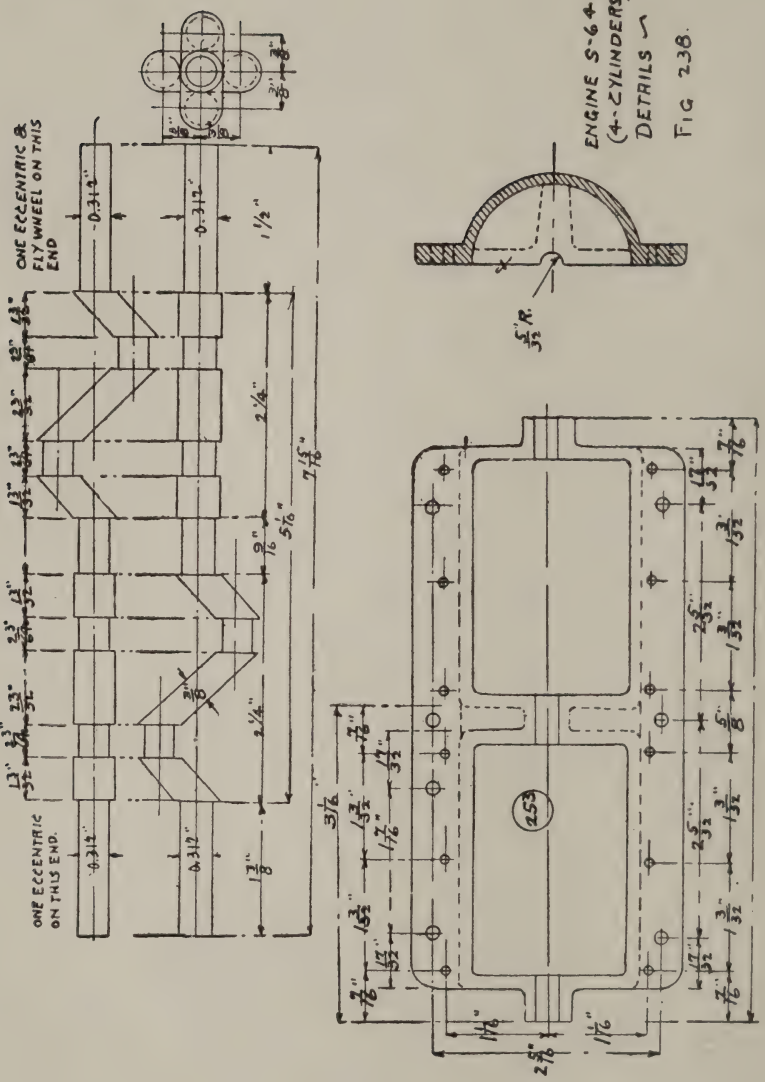
ENGINE - S-62 + S-64
(2-CYLINDERS.) (4 CYL.)
-DETAILS-
FIG. 236.



ASSEMBLY OF ENGINE S-64 - (4-CYLINDERS)

ALL DETAILS EXCEPT, BASE PIECE 253 & CRANK SHAFT PIECE 265 ARE SIMILAR, EXCEPT AS TO QUANTITY, AS S-62.

FIG-237


ONE ECCENTRIC ON THIS END.
ONE ECCENTRIC & FLY WHEEL ON THIS END
0.312"
0.312"
0.312"
1/2"
2 1/4"
2 5/16"
5 5/16"
7 15/16"
1 7/8"
1 1/4"
3/8"
3/8"
3/8

them. Arrangements have been made with the Boucher Co. by which those who desire may purchase parts of the motors in rough castings, machined castings, ready to assemble or the units completely assembled, ready to run.

Any person who builds one of the boats successfully will have no difficulty in assembling the finished castings of the motors. No one but an expert should attempt to construct one of the boilers or the blow torch because they must be absolutely tight to be safe. No special description is therefore given for the construction of the power plant units other than the drawings because, to successfully teach machine shop practice is beyond the scope of this book.

CHAPTER XX

POWER BOAT MAINTENANCE AND OPERATION

Model power boats are lightly built in order to make them fast, and their construction is similar to rowing shells. Such boats are not allowed to "soak" in the water for hours at a time. It is customary to remove the shells from the water when the run is over and wipe them dry inside and out. One should treat a small power boat in the same manner, thus keeping the hull true and in good shape for years.

Model power boats are usually too fast to permit overtaking in an ordinary rowboat. The usual practice in racing them is to run them into a net stretched across the water or to set the helm (rudder) slightly in order to guide them in a "great circle." The boats may be stopped by catching them by hand in the path of this circle.

Model speed boats are raced by permitting them to run about a stake or pipe, held by a man, in the center of a shallow body of water. The boats are held to the center upright by means of a strong fishing line one end of which is hooked into an eye on the side of the model and the other end being tied to a ring which in turn is placed over a nail in the top of the stake. This permits the string to turn freely. In real races, a piece of pipe is used, high enough to clear the man's head, and the top is arranged with a ball bearing cap which turns easily with the pull on the cord.

Since the exact length of the cord can be easily determined, it is easy from this to secure the circumference of the circle that the boats must travel and by timing them carefully it is possible to determine the exact speed. Of course, it is necessary that the boats, in making a given run, keep the string taut at all times, otherwise the circle will be shortened and the test will not be fair.

In securing the fishing line to the side of the model, it is customary for each boat to be equipped with a brass or copper strip along one side, at the sheer, and since this strip is perforated with a number of holes, it is possible to hook the line in at the point where it will just balance the pull of the rudder. If there is too much pull, it will tend to slow the boat down, but if there is not enough, she may slacken up the cord. The idea is to set this hook and the rudder so that they just balance when the boat is at speed.

Races may consists of six laps about a circle with a fifty foot radius, but no matter how many circuits are required, the boat should be capable of keeping up sufficient steam to complete the run. That is one of the fine points of model racing.

If the power boats are allowed to run free on a lake and one of them rammed a boat or a float they would be apt to wreck themselves in the same manner that a large high speed boat would, under similar circumstances. I have released boats completely free on a large smooth lake where there were no other craft operating at the time and followed them with a power boat. Another way is to limit the amount of fuel under the boiler.

The working parts of the machinery and propeller bearings should be kept well lubricated with good medium weight oil. A slight amount of light oil should be kept in the crank case of each motor. There is a filling plug provided for this purpose. This allows oil to be splashed to all of the lower bearings of the motor.

An ingenious oiling device is provided and hooked up with the steam line from the boiler which forces a small quantity of oil into the cylinders with the steam. The device consists of a "dead end" or small receptacle attached to the steam line and as steam slowly condenses and settles in the dead end the oil rises and is forced into the cylinders.

The boilers are provided with a combination filling plug and safety valve, a steam gauge and a water gauge.

The gasoline blow torch for firing the boiler is provided with a combination filling plug, air inlet valve and outward check.

Assuming that we are about to operate one of the power speed boats, the procedure would be as follows:

The boat is of course completed, the motor is secured to its bed, properly lined up with the shaft and bearings, the boiler is in place and secured to the bearers and the steam supply line is hooked up with the engine. The blow torch is in place in its bearers so the forward end of the nozzle extends $\frac{1}{2}$ inch into the boiler. The blow torch should not be secured in place so that it cannot be removed. It should be fitted into its chocks, however, so that it cannot shift when the boat rocks and pitches in the water.

First remove the blow torch and fill it three-quar-

ters full with good gasoline, through the filling plug; replace the plug and pump a little air into the tank by connecting a bicycle tire pump to the air inlet valve. Pump enough air in so that the gasoline will squirt out of the spray nozzle when the needle valve of the torch is opened. Close the needle valve and pump a little more air in. Fill the pre-heating pan with denatured **grain alcohol,** do not use wood alcohol or gasoline, because they will plug the small spray opening with carbon so the gasoline cannot run freely. Place the blow torch on the ground away from anything that it can set fire to, and if there is a wind blowing shield it. Then light the alcohol in the pan and allow the burner to heat; the alcohol may boil over slightly and set fire to the ground near the burner, but this will not hurt. When the alcohol is nearly all consumed open the needle valve slightly and if the burner lights or, when the needle valve is opened wide, it makes a good "healthy roar" the burner is ready to put back in the boat. If the burner does not light properly **put the flame out first** and refill the pan with alcohol and relight it. Next time the burner is opened the torch should be sufficiently heated to properly light. Turn the burner up to test the flame and then cut the flame down and quickly place the burner in the boat in the proper position to fire the boiler after the boiler has been three-quarters filled with clear, clean water. Allow the boiler to heat up gradually, with the burner flame somewhat reduced from the full, or for about three minutes, then, if desired, the burner may be turned up full.

In filling the boiler remove the combination filling plug and safety valve with a small wrench and be

careful to fill the boiler only three-quarters full. Have the boat level and watch the water in the glass water gauge. Replace the filling plug, screw it in tight to prevent a steam leak. Watch the steam gauge and when there are three or four pounds of steam open the engine throttle valve **slightly,** just enough to allow enough steam to enter the engine cylinders to warm them. Turn the engine over by hand by the flywheel. Work all the water out of the engine that is caused by the steam condensing when it comes in contact with the cold parts. Gradually open the valve wider, (when eight or ten pounds show), working the flywheel all the while until the steam takes charge and runs the engine. **This is important:** Only run the engine slowly until it heats up and until after the boat is placed in the water. If the high speed engine is allowed to race when the boat is not in the water, where the action of the propeller tends to hold it back, the engine will be damaged.

Never fill the boiler over three-quartrs full. Never fill the boiler when it is extremely hot and nearly dry. Never fill the gasoline tank over three-quarters full and never fill the gasoline tank without filling the boiler, (three-quarters full). The reason for this is that with the gasoline tank three-quarters full and the boiler three-quarters full the gasoline will be consumed first, if the boat is allowed to run until it stops. In this way the boiler will not be injured. Never leave water in the boiler in a place where it might freeze. Take the hot condensed steam water out of the inside of the boat with a small sponge after you are through running the boat.

Due to the poor grade of gasoline on the market,

the small opening in the spray nozzle of the gasoline burner sometimes becomes clogged with carbon, thus preventing the burner from operating efficiently. Under such circumstances unscrew the square burner spray nozzle and insert a fine needle in the hole and clean the carbon out thoroughly.

In operating the boats be extremely careful not to use them in a lake or pool of insufficient depth. The motors turn up extremely fast when at full speed and if the propeller hits anything it would not only bend it but probably the shaft and the strut also. **It would be impossible to repair them anything like their original efficiency** and would be necessary to install new parts. You are a skipper of a real boat, so do not take chances, be as careful as is necessary for the captain of a large passenger liner. If you are mindful of the precautions herein stated, the boats will not be damaged.

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